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Scientific American

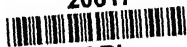
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REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY

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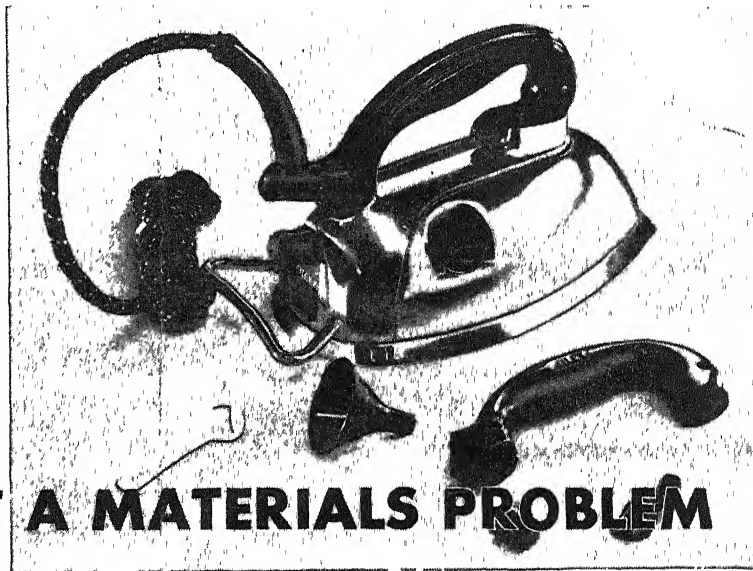


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Is DDT Poisonous? . . . See page 5

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IRONING OUT A MATERIALS PROBLEM

A typical "postwar" item is this Silex Steam Iron illustrated. Like so many new products which are a part of our long-awaited civilian economy, this revolutionary home appliance makes prudent use of Durez phenolic plastics.

Why Plastics?

Notice the eye-appealing, heat-resistant handle. Exhaustive tests proved that plastics were better suited for this purpose than any other material known. Their use resulted not only in a better finished product but also in a product which could be produced very economically.

Why Phenolic Plastics?

Of all plastics, the phenolics are the most versatile. Naturally, this makes

them the logical starting point for the design engineer with a materials problem. The handle of this Silex Steam Iron, for example, called for heat resistance, smart appearance, pleasant and hand-fitting "feel," moisture resistance, and excellent moldability . . . all inherent characteristics of phenolic plastics.

Why Durez Phenolic Plastics?

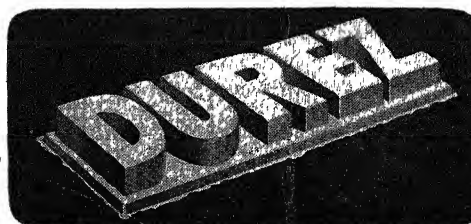
The more than 300 multi-proprietary Durez phenolic molding compounds available today are the direct result of a quarter century's continuing research and product development on the part of Durez laboratory technicians. This rich background and the high quality of the materials themselves are convincing reasons why

manufacturers in every field of industry look to Durez for the plastics that fit their jobs.

Experienced Assistance Available

Do you have a plastic materials problem? If so, see your custom molder. Wartime developments have endowed him with many new molding methods and processes so that his services are even more valuable than before. Should further assistance be necessary, the competent advice of experienced Durez service engineers and a wealth of proved product development data await your request.

Durez Plastics & Chemicals, Inc., 5213 Walck Road, North Tonawanda, N. Y.
Export Agents: Omni Products Corporation,
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PHENOLIC
RESINS

MOLDING COMPOUNDS

INDUSTRIAL RESINS

OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

Scientific American

Founded 1845

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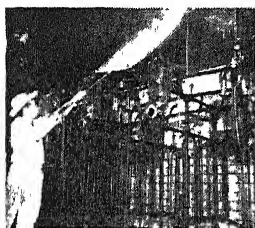
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Our Cover: Wide use is being made of various DDT compounds for insect control. Our cover picture, used by courtesy of Geigy Company, Inc., shows a power method of application. The general subject of DDT is discussed in the article starting on page 5.

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JANUARY 1946 • SCIENTIFIC AMERICAN

All the
essential facts...

ATOMIC ENERGY

IN WAR AND PEACE

By GESSNER G. HAWLEY,
Chief Technical Editor,
Reinhold Publishing Corp.

and

SIGMUND W. LEIFSON,
Professor of Physics,
University of Nevada

If you want a clearer understanding of what atomic energy is, and how it will affect man's social, economic, and political life — you'll want to read **ATOMIC ENERGY IN WAR AND PEACE**.

Carefully prepared by a brilliant science writer in collaboration with an eminent physicist, this book explains the nature and uses of this amazing discovery. It is a logically coordinated presentation of the essential facts drawn from thoroughly reliable sources which surveys the background of combustion, explosions, atomic structure, radioactivity, and nuclear fission to furnish a well-rounded view of this revolutionary new force.

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330 West 42nd St., New York 18, N. Y.

50 Years Ago in . . .



(Condensed from Issues of January, 1896)

X-RAY — "There have been received from Europe by cable very insufficient accounts of a discovery attributed to Professor Roentgen, of Wurzburg University. By the use of a radiant state of matter tube, a Crookes tube, it is stated that he has succeeded in obtaining photographic effects through opaque objects. . . Metals cutting off all rays alike would produce a shadow, so that a metallic object in a box or embedded in the human system could be made to give some kind of an image. The operations are said to have been conducted without a lens, entirely by shadow."

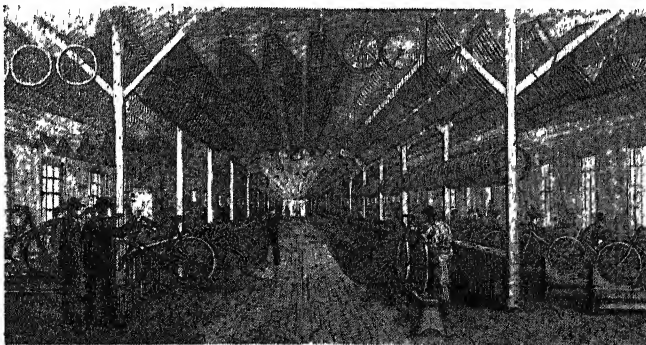
TRANSPORTATION — "Electric street traction has continued to grow in favor. In 1887 there were only 13 electric roads in the United States; today there are 850 roads with a total mileage of 10,000, representing an investment of \$400,000,000. In this connection it is interesting to note that the possibilities of canal towage have been tested in both the old and new worlds; here in the form of a traveling motor, working separately from the boat, and in France by the use of a motor upon the boat itself, hauling upon a chain laid in the bed of the canal."

SUBMARINE — "A new submarine boat, the Goubet, resembles a whale in shape, being spindle shaped and measuring 26 feet in length and about 5 feet 6 inches in diameter in the middle, with a capacity of 10 tons. . . The boat is propelled by a screw, which also serves the purpose of a rudder, the shaft being pointed to enable of its being moved right or left. . . The motive power is supplied by an electrical battery."

HELIUM — "N. A. Langlet has succeeded in obtaining helium perfectly free from nitrogen, argon, and hydrogen, when tested spectroscopically. This gas, when weighed in the usual manner, proves to be exactly twice as heavy as hydrogen, the usual standard, its density in relation to air being 0.139."

TAXI! — "M. Roger, manufacturer of automobile carriages, has made application to the police authorities of Paris for permits to run a number of horseless carriages on the streets; for hire at the regular legal rate of 30 cents a drive or 40 cents an hour. . . That horseless carriages can be run cheaply enough to compete with the regular fiacres is thus shown."

BICYCLES — "Within the past three years, the American bicycle industry has grown up to dimensions which fairly entitle it to be considered representative of the country and of the day. . . The industry has brought about an enormous development in the manufacture of special tools and of parts of bicycles. . . For the production of the absolutely



A bicycle assembly line of 1896

high grade American bicycle, a factory is required which will turn out practically all the parts of the wheel manufactured, for unless such is done one concern cannot be answerable for the perfection the whole machine."

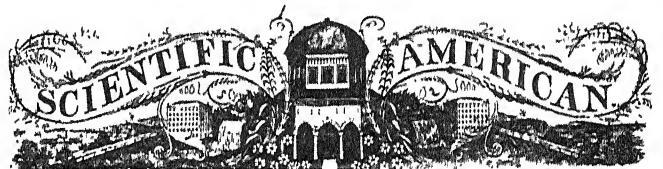
CAR WEIGHT — "Railway cars could be lightened in their construction by the substitution of high grade steel for timber. The use of nickel steel for the floors and side trusses, with thin plating for sides and roof, would result in a light, but very stiff and strong car. By furnishing the interior with rattan or basket work chairs and lounges, such as are to be found on some lines today, a further saving of weight could be effected."

NIAGARA POWER — "The generators at the Niagara Falls Electric Power Plant, which may be termed a genuine triumph of electrical engineering, are of the Tesla vertical type, and were built by the Westinghouse Electric Manufacturing Company. For each generator there is a turbine wheel. The axis of the generator comes directly in line with the axis of its own turbine, situated 150 feet below it."

ENGINES — "Gas, gasoline and petroleum oil engines are daily becoming more popular, and not only is the number of regular manufacturers becoming very large, but many amateurs are trying their hands at the production of engines of this class. . . One of the most difficult problems is that of providing an efficient means of igniting the explosive charge in the cylinder at the proper instant without intermissions or failures. . . The electric spark, taken all in all, is probably the best igniter."

RESONANCE AND ECHO — "Architects should keep in mind the rule that resonance, such as is to be obtained by thin elastic linings, or even by masses of air judiciously distributed, is a thing to be sought in designing rooms for hearing music, or for public speaking, while echo, such as is produced by hard unyielding surfaces, is to be avoided as much as possible."

100 Years Ago in . . .



(Condensed from Issues of January, 1846)

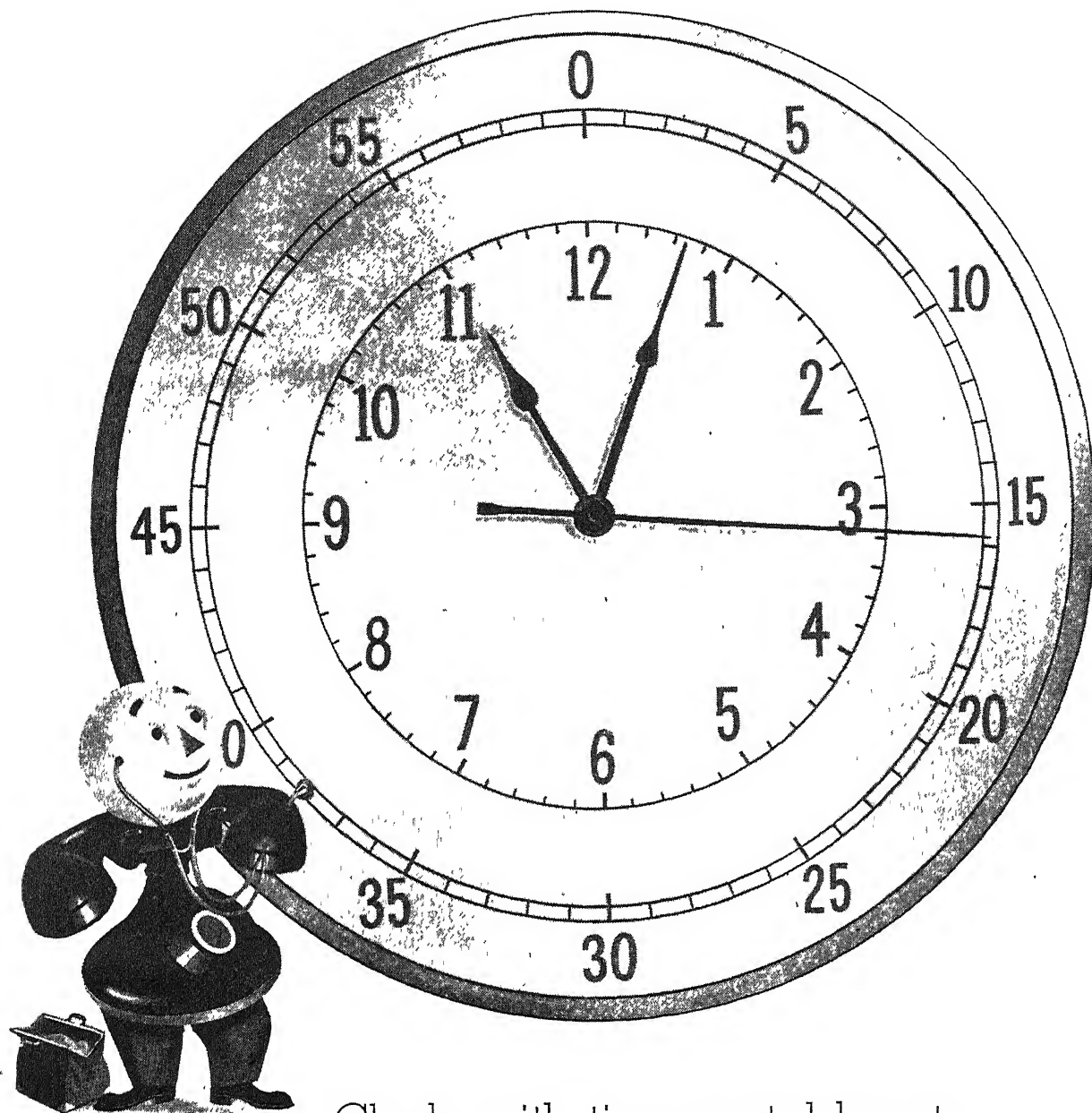
ELEVATED — "We have heretofore alluded to the constructing of Elevated Railroads over the centers of some of the principal streets of this city; since which we have more attentively examined the subject, and are fully convinced of the practicability not only of constructing such roads, but of rendering them unobjectionable to the citizens resident on those streets."

MAGNETISM — "Galvanic Electricity, under certain circumstances, is capable of inducing magnetism more powerful in its effects than that of any permanent magnet."

RAILROADS — "Every railroad company . . . should be made to know that they are in some measure dependent on the public; and all travelers, and men of business, should from principle refrain from patronizing companies who neglect due accommodation of the public."

TELEGRAPH — "The magnetic telegraph line between Philadelphia and Norristown commenced operations about a week since. The line between this city and Philadelphia is finished and has commenced operations."

BELLS — "We learn that 258 bells averaging 534 lbs. each have been cast at the extensive foundry in West Troy during the past year—just 113 more than in 1844."



Clocks with tiny crystal hearts that beat 100,000 times a second

CRYSTAL HEARTS beat time in Bell Telephone Laboratories, and serve as standards in its electronics research. Four crystal clocks, without pendulums or escapements, throb their successive cycles without varying by as much as a second a year.

Precise time measurements may seem a far cry from Bell System telephone research, but time is a measure of frequency, and frequency is the foundation of modern communication, whether by land lines, cable, or radio.

These clocks are electronic devices developed by Bell Laboratories, and refined over years of research. Their energy is supplied through vacuum tubes, but the accurate timing, the controlling heart of the clock, is provided by a quartz crystal plate about the size of a postage stamp.

These crystal plates vibrate 100,000 times a second, but their contraction and expansion is submicroscopically small—less than a hundred-thousandth of an inch. They are in sealed boxes

to avoid any variation in atmospheric pressure, and their temperatures are controlled to a limit as small as a hundredth of a degree.

Bell Laboratories was one of the first to explore the possibilities of quartz in electrical communication, and its researches over many years enabled it to meet the need for precise crystals when war came. The same character of research is helping to bring ever better and more economical telephone service to the American people.



BELL TELEPHONE LABORATORIES *Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.*

Previews of the Industrial Horizon

TELEVISION ON THE MARCH

TECHNICAL advances in television transmitting and receiving equipment are encouraging for the future of the industry. Already available are the image orthicon super-sensitive camera tube, described on page 11, and developments in microwaves (page 28) that now permit high-power operation on television wave-lengths. These, together with small yet brilliant cathode-ray tubes for receivers, which permit construction of relatively low priced equipment, should boom the television market in the very near future.

BETTER RUBBER

IX TIMES as fast as conventional methods, and capable of turning out better rubber products, is the way electronic curing and drying of rubber is characterized by Westinghouse engineers. Under "For Future Reference," this page, July 1945, electronic vulcanization of rubber was pointed to as an important probability. Now the process is here to stay (see also page 32, this issue) and is being applied not only to tires but to mattresses, cushions, elastic threads, rubber wheels for industrial trucks, and so on.

FUNDAMENTAL RESEARCH

GUIDING purpose of the Stevens Research Foundation, established as a non-profit corporation by Stevens Institute of Technology, will be to investigate any promising fields pertaining to industry that will improve the technical and economic life of the country. Here is not just another organization to conduct routine test work or to engage in factory "trouble-shooting." In fact, problems of these natures will be passed along to the many groups already available for such work; Stevens Foundation will concern itself with more fundamental projects. Thus the Foundation will make available a means of investigating problems of industrial significance which, if left to individual companies, could be tackled only by those of the highest order of magnitude—those with relatively unlimited resources that can afford to concern themselves with matters which have no immediate probabilities of profits.

FOOD FOR THE FUTURE

ASK ALMOST any returned G. I. for his opinion of dehydrated food. His reply, stripped of the almost inevitable profanity that accompanies discussion of Army or Navy chow, will probably indicate that, for his part, dried foods of all kinds are out—definitely out—of his life forever. Perhaps much of this attitude can be attributed to the relatively poor quality of dehydrated foods that were supplied in the first rush of the early days of the war. Perhaps another large part of it is the contempt that accompanies familiarity. In any event, it appears that, of the 141 food dehydrators in the United States at the peak of war demand, only about a quarter of them intend to try to stay in business.

But now comes Clarence Birdseye, of quick-frozen-food fame, with the announcement of a new "anhydrated" food process that differs from ordinary dehydrated food in much the same manner as quick-freezing differs from slow-freezing. In the new Birdseye process, the foods—a wide variety of them, including carrots, broccoli, and mashed potatoes—are quick-dried to reduce weight and volume and then packaged for sale. The time of drying is reduced from the usual 16 hours or so to about 90 minutes. At the same time, the foods are partially cooked during the drying process and require only a few minutes—four to ten—for final preparation before they are put on the table.

Result of the anhydrating process is a reduction of from

By A. P. Peck

88 to 95 percent in weight and a corresponding saving in bulk. To the store-keeper this means reduced storage space plus longer keeping time for vegetables; to the housewife will accrue similar advantages, with the added factors that the vegetables are ready for use and have minimum waste.

Regardless of the G. I. opinion of dried foods, many of them are going to eat the new anhydrated foods in the future—and like them, if this writer's experience in eating (and preparing them) is any criterion.

FOOD PACKAGING

BEFORE leaving the three-times-a-day important subject of food, passing mention must be made of a new packaging method for quick-frozen foods that has definite industrial implications for tomorrow. The new package, developed by Continental Can Company, has a treated paper body and metal ends. Flat and rectangular in shape, it conserves space; because of its construction, it offers maximum protection against dehydration (not desirable in frozen foods), oxidation, loss of flavor, acquisition of off-flavors, leakage, and loss of vitamins. Of industrial importance is the new package's adaptability to automatic filling and closing operations, with consequent reductions in labor costs.

AIRPLANE POWERPLANTS

IMPORTANT on the airplane horizon, and becoming more so every day, is the jet engine, used either for its reaction thrust alone or for combined thrust and conventional propeller operation. There is no doubt that these prime movers will be in the big-business class in the very near future. Both General Electric and Westinghouse, for example, are busily exploring their possibilities and exploiting their potentialities. Thus, a G. E. engineer has predicted a 10,000 horsepower unit for the future but has cannily refused to place this figure as the upper limit. A Westinghouse technologist looks to gas turbines of 5000 to 8000 horsepower "within the next few years."

The probabilities are that the gas turbine, no matter how its power is applied, is the coming prime mover for aircraft of large size and high speed. But the aircraft field is certain to be shared for many years to come by the turbine and the more familiar reciprocating engine. These latter will continue to power planes of small size and relatively slow speed, while the turbine will extend greatly both the top speeds and cruising range of larger commercial ships.

FOR FUTURE REFERENCE

BIGGEST PROBLEM of the rubber industry in the immediate future is the adjustment of the nation's huge synthetic output to the increasing supply of natural rubber. . . Aluminum Company of America, with its enormously increased wartime productive capacity, is girding for battle for expansion in fields where it had pre-war holds, as well as in brand-new markets for its products. . . Ford's new foundry methods bring the molds to the molten metal, instead of vice versa, with resulting economies in time and labor. . . Those manufacturers who conduct continuing research in product improvement, instead of waiting until competition forces them into improvements, are the ones who keep on top of the pile; it is too late to start research when compelled to do so by loss of business.

Is DDT Poisonous?

Legends of All Kinds Have Been Built Around this Newest of Insecticides. It is Poisonous, but . . . Many of the Troubles are Traceable to the Solvents Used. There is Nothing to Fear if the Material and Products Containing it are Handled With Respect

By D. H. KILLIFFER
Chemical Engineer

TREMENDOUS publicity and intense general interest have already built up numerous legends around DDT, the new war-proved insecticide. Unquestionably effective in many important applications, DDT owes its value to its toxicity, a fact which many people seem surprised to discover. Because of its toxic character, DDT will kill insects and for the same reason it will cause disagreeable symptoms, if not death, in warm blooded animals and persons under certain circumstances. That seems elementary. But reports of the effectiveness of the insecticide have grown to be barely less fantastic than baseless tales passed around, which presumably confirm the hazards incurred through using it.

Typical is the story of Henry's dog. It seems that Henry's dog had a prolific crop of fleas during the summer of 1945 and that Henry sought to relieve the animal's suffering by dusting it with DDT. Later the dog died and apparently became at once a martyr. As I heard the story first it went something like this:

After the dusting with DDT, the animal lived on in comfort for about a month. At the end of that time, Henry was called out of town for a time and left the animal at a nearby kennel in his absence. The veterinarian in charge noticed that the dog was dirty and instructed the attendant to give the dog a bath. That was done using a high grade castile soap shampoo, and as soon as the dog had been completely lathered, it died right in the attendant's hands. Such was the interest of veterinarians in the dire fate of Henry's dog that no

less than four from the surrounding countryside were present at the autopsy and saw indisputable proof that the animal had died of poisoning from the DDT dusted on its coat a month previously and only now activated by being emulsified by the copious lathering.

CIRCUMSTANCES CHANGE—That is a pretty dreadful fate for a dog and so I inquired of Henry himself as to what had happened to his pet and what were the circumstances. I learned: (1) that the dog was well along in years; (2) that the bath was given two days after the dusting and with a strong pine oil preparation intended to assist in clearing up a skin irritation that had troubled the dog for some time; and (3) that

the dog survived the bath by a month. I also learned that it was reasonably certain, on the basis of the veterinarian's report, that the dog's death was due to apparently natural causes far less spectacular than DDT. And thus the object lesson in caution with which I had hoped to start this article collapsed.

Several other stories of DDT's harmful tendencies similarly petered out when an earnest effort was made to confirm them. Like the one about the lady in New York City who suffered serious frost bite on two fingers from using an aerosol bomb that she couldn't shut off and who blamed the injury on DDT. So many were traced out and found baseless that I have come fully to believe that one must try hard to be harmed by DDT.

RELEASE SUFFERINGS—Like many other novelties growing out of the war, DDT suffers from its sudden release from war-time censorship and restricted production. Many factors set the American stage in the best possible manner for the mushrooming of fantastic tales: partial information allowed to be published during the war years; the demonstrated high value of the stuff against body vermin; tremendous demand for the meager output of American plants to meet war demands; lack of men, materials, and, above all, time to extend investigations of the material into all fields interesting to civilians; and the reports spread by enthusiastic GIs of the magical effectiveness and extraordinary safety of DDT as they have used it. Now authentic information from reliable sources sounds a warning note of caution, and suddenly the slightest mishap is magnified into a great calamity. Any harm to man or beast connected with DDT is reported in expanding



Courtesy Westinghouse
A DDT "bomb" in the home

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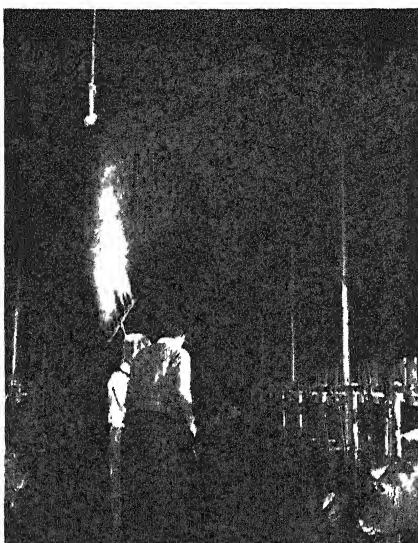
detail by scaremongers as tending to show that DDT should be banned.

Meanwhile, demand has built up for the product during its restriction to military use. This demand overwhelmed legitimate producers soon after the ban on DDT's use by civilians was lifted. The excess of demand over supply created opportunities for every shyster and marginal manufacturer to produce and market DDT. It is all very confusing and much in need of clarification.

First clarification should be to define DDT. It is a white crystalline chemical compound rejoicing in the name of 2, 2 Bis (p-Chlorophenyl) 1, 1, 1, trichloroethane. It can be produced without great trouble by chemical manufacturers by the reaction of chlorobenzene with chloral in the presence of sulfuric acid. No patent covers the preparation but the hazards of handling the intermediates and the product require that only skilled and experienced persons in properly equipped plants should undertake the synthesis. It is decidedly not an enterprise for neophytes. The reaction that produces DDT at the same time gives rise to other compounds which also seem to possess insecticidal value.

But DDT as produced is in a form by no means satisfactory for use against insects. It must be extended with other things to make it fully useful. Some aspects of its applications are covered by a United States patent issued to Paul Mueller, a citizen of Switzerland (U.S.P. 2,329,074 of September 7, 1943). It may be used in the form of a dust diluted with talc or other powders. In solutions or emulsions, it may be applied to many purposes. It may also be included in the aerosol bomb. Each of these forms has its particular values.

TOXICITY—The questions of toxicity of such preparations are most effectively answered by official



Courtesy Gelgy Company, Inc
"Neocid" barn spray, containing DDT, may be used as a residual type spray against flies and mosquitoes or as a dip against cattle and goat lice and sheep ticks. This insecticide is supplied in a wettable powder form that is stable in water suspension

statements from those best qualified to know. Dr. H. O. Calvery of the Food and Drug Administration and Dr. Paul A. Neal of the National Institute of Health have issued this joint statement:

"The extensive animal experimentation and investigative agricultural uses indicate quite clearly, we believe, that DDT is a deleterious substance. On the other hand, the use of DDT by the armed forces as well as the above experimental work on animals has shown that DDT insecticide can be used safely when properly labeled and handled with adequate precaution. DDT is not a caustic poison, a primary irritant, and probably not a sensitizing agent. For example, it is not dangerous like carbolic acid, thallium, strychnine, bichloride of mercury, aniline, methyl bromide, cyanides, fluorides, arsenic trioxide, caustic acids and alkalies, and so on. This group of chemicals are so dangerous that they

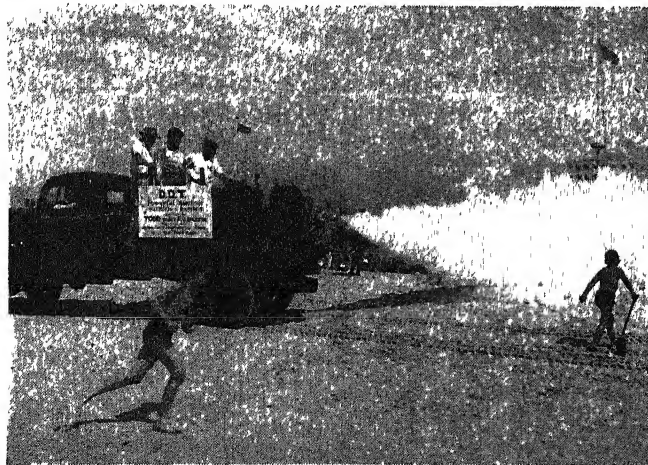
must be handled with extreme care and the labeling must be so distinguishing as to thoroughly warn the handler and user. If substances like DDT are classed with these and the individual learns that he can submit to considerable exposure without eye irritation, skin irritation, or any subjective signs of harm, he instinctively but unconsciously begins to disregard such warning labels and the hazard to health is vastly increased. Therefore, it is our opinion that DDT does not belong in the class of compounds usually labeled "Poison" with the skull and cross-bones. DDT does, however, warrant the exercise of caution in its handling and use and as a result we as toxicologists feel that such caution statements as are recommended by the Insecticide Division are appropriate."

A previous statement by Dr. Calvery also has a direct bearing on the subject:

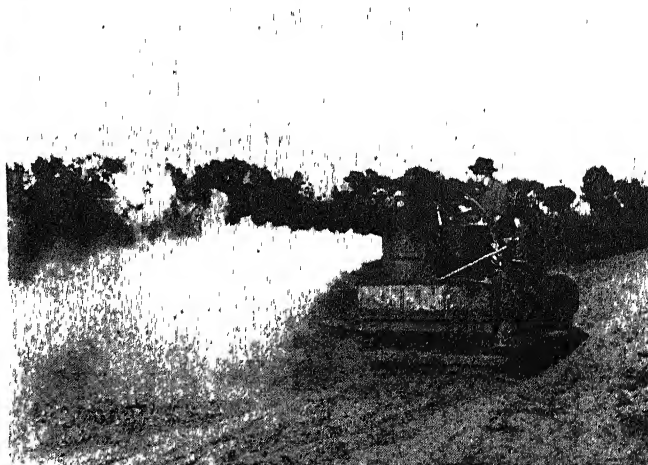
"DDT, the much publicized insecticide, is a toxic substance. The toxicity of DDT to humans is of a sufficiently low order to permit the use of DDT without danger to personnel if reasonable precautions are taken. In spite of the extensive employment of this insecticide to date, there has been no reported established case of poisoning. This is, in large part, the result of observing previously published precautions and should not be interpreted as an indication that any relaxation in the observation of those precautions is warranted. . .

"None of us has yet seen a case of anyone poisoned by DDT, but our laboratory tests show that poisoning is possible. . .

"We receive many reports of poisoning blamed on DDT. One told of dizziness from spraying all day. Most DDT spray solutions have been based on kerosine and the reported dizziness is a perfect textbook picture of kerosine poisoning. As true with many reports, the public are



Courtesy Todd Shipyards Corporation
DDT rids beaches of annoying insects



Courtesy Colonel Dale Bumstead
Spreading a DDT mixture with a Todd fog applicator

just not aware of the toxicity symptoms of commonly used materials. To date we have not seen a case of anyone poisoned by DDT."

BEST INFORMATION—In a letter on the subject of DDT toxicity, Dr. Neal quotes the following statements summing up the best and latest information available

"Although DDT is deadly to many insects, it is not harmful to man if properly applied. DDT is definitely less toxic than Paris green and sodium fluoride—long in use as common insecticides. But, as with any insecticide, there are certain precautions which must be taken to avoid any possible harmful effects.

"In spite of its toxicity, no harmful effects have been observed in animals exposed in rooms containing many times the recommended insecticidal concentration of DDT in sprays or dusts. But careless use and exposure to abnormally high concentrations of DDT may cause toxic effects. Therefore, it is essential to follow carefully the directions for its use as a household insecticide.

"It is very unlikely that food contaminated with DDT from ordinary home use will cause toxic effects in man, but such contamination should be avoided by removing food from the room or covering it during spraying.

"DDT in *dust form* is not absorbed through the skin unless greases, oils, or greasy skin lotions are already present on the skin. Nevertheless, DDT powders should not be allowed to remain on the skin, and excessive inhalation of the powder should be avoided. Since the diluted dust (if uncolored) may be mistaken for flour or other foodstuffs, the material should be carefully labeled and every precaution taken to keep it away from children. Any danger of food contamination should be avoided.

"DDT in *oil solution* is readily absorbed through the intestines and is also absorbed directly through the skin. Therefore, DDT-oil solutions should not be allowed to remain on the skin or saturate clothing. Wash the hands and exposed skin with warm soapy water; and if oil solutions or concentrates are spilled on the clothes, change them promptly. Avoid inhaling the mist and contaminating food with the spray. *Never use it on the skin or coat of animals.* If the solvent is inflammable don't use it near a fire.

"It should be pointed out that many of the solvents (kerosine and so on) used in preparing DDT insecticides in themselves may cause irritation of the skin and other harmful effects when handled carelessly.

By observing proper precautions and cleanliness, these can be avoided.

"If a good deal of spraying is to be done it is advisable to wear gloves, goggles, and a respirator to avoid excessive contact and inhalation of DDT and its solvents."

NO ACTUAL POISONINGS — A subsequent statement by the Industrial Hygiene Division, U. S. Public Health Service contains the following:

"Before the Army's release of the insecticide for field use by its personnel, extensive tests of biologic effects were made by this laboratory. No case of poisoning actually due to DDT has occurred in the United States, reports the Chief of the laboratory. In more than two million persons exposed to DDT in its use by the Army for control of insect-borne diseases, no case of poisoning is known to have occurred.

"Those cases of toxicity which have occurred to the present time have been found to be due to the solvents used in the DDT mixture. Many of these solvents, such as kerosine, xylene, and others in themselves may cause irritation of the skin and other harmful systemic effects when handled carelessly. Such effects may be avoided by observing proper precautions and strict personal cleanliness. It is recommended that the chlorinated hydrocarbons, with the possible exception of methylene chloride and trichloroethylene, should not be used as solvents for DDT."

Obviously, when properly handled, DDT is one of the safest of the various dangerous substances used by the American people and there is nothing to fear if the material and products containing it are handled with proper respect. Clearly, too, the great value of DDT fully justifies proper precautions in its use. One such precaution is to use the products of trustworthy manufacturers and to avoid fly-by-night products having no responsible sponsor.

Yes, DDT is poisonous but it is extremely useful if you treat it right.

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DRYING OILS

Obtained by Electrolytic Reduction of Glucose

SORBITOL, an alcohol containing six hydroxyl groups and made by the electrolytic reduction of glucose, has been found to yield drying oils of uniquely valuable properties when combined with the fatty acids

of linseed oil, replacing the glycerol naturally present. Glycerol, the alcohol naturally present in fats and oils, has three hydroxyl groups as compared with four in pentaerythritol and six in sorbitol. Each of these polyhydric alcohols imparts valuable properties to drying oils and apparently the greater the number of hydroxyl groups, the quicker drying is the product. Varnishes made with the sorbitol oils are reported to dry to a hard finish.

YEAST VS. FAMINE

Special Product Is High in Vitamin B

GROWTH of a special yeast high in protein and the B vitamins is being undertaken in the West Indies with the expectation that the highly concentrated nutriment of the product may be especially valuable in war-torn Europe. The yeast product has a protein content of 40 to 50 percent and is expected to cost about 12 cents per pound, when produced from sugar cane grown in Jamaica. The average person's daily requirement of protein and B vitamin is reported to be met by about half an ounce of the concentrated yeast.

PRESERVATIVE

May be Perfected From Penicillin

PENICILLIN, heralded for its feats in conquering infections, has been suggested by United States Department of Agriculture scientists as a possible preservative of foodstuffs. Tests have shown the drug's effectiveness against many types of microbes, but not all, and while it seems likely to have value, much more research is necessary to show how it should be used. Tests on milk are promising but not conclusive.

ARTIFICIAL FALL

Aids in Harvesting Many Crops

CHEMICAL dusting of cotton plants to cause their leaves to fall when desired in order to allow mechanical pickers to handle the crop has proved successful and is now moving into other fields of usefulness. Similar dusting defoliates tomato plants and lets the sun reach the fruit to ripen it as the season advances. Removal of the leaves from vines is reported to simplify harvesting soy beans. Other applications of the new technique are expected to benefit those who can't wait for Nature to bring on Fall in due course. Active principal of the dust used is calcium cyanamide.

Boron Carbide: A Challenge

Industry Has Available a Material which Can Be Put to Many Production Uses, When Means Are Found to Capitalize Fully on its Advantages and Overcome its Weaknesses. Already Boron Carbide is Being Used in Blast Nozzles, Gages, and Specialized Cutting Tools

By FRED P. PETERS

Editor-in-Chief, Materials & Methods

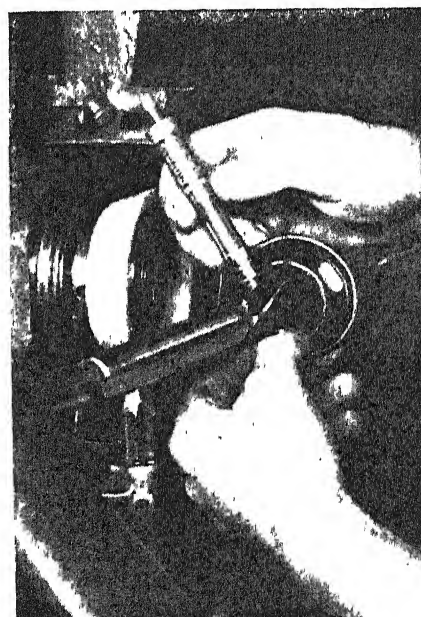
IF EVER an industrial material could be said to be "noble" then boron carbide is that material. The word "noble" in the industrial argot means "not susceptible to attack by other materials," as in the case of gold, which is not readily attacked by acids, and pure silver, which does not oxidize at room temperatures. And boron carbide is less susceptible to attack than almost any other material known to industry. Acids will not etch it; only diamonds will cut it (and then only very slowly),

alkalies do not bother it; water will not rust it; heat at temperatures ordinarily found in industrial furnaces will not melt it; intense cold will not weaken it; and electrostatic charges will not gather on it. It cannot be swaged, forged, or extruded.

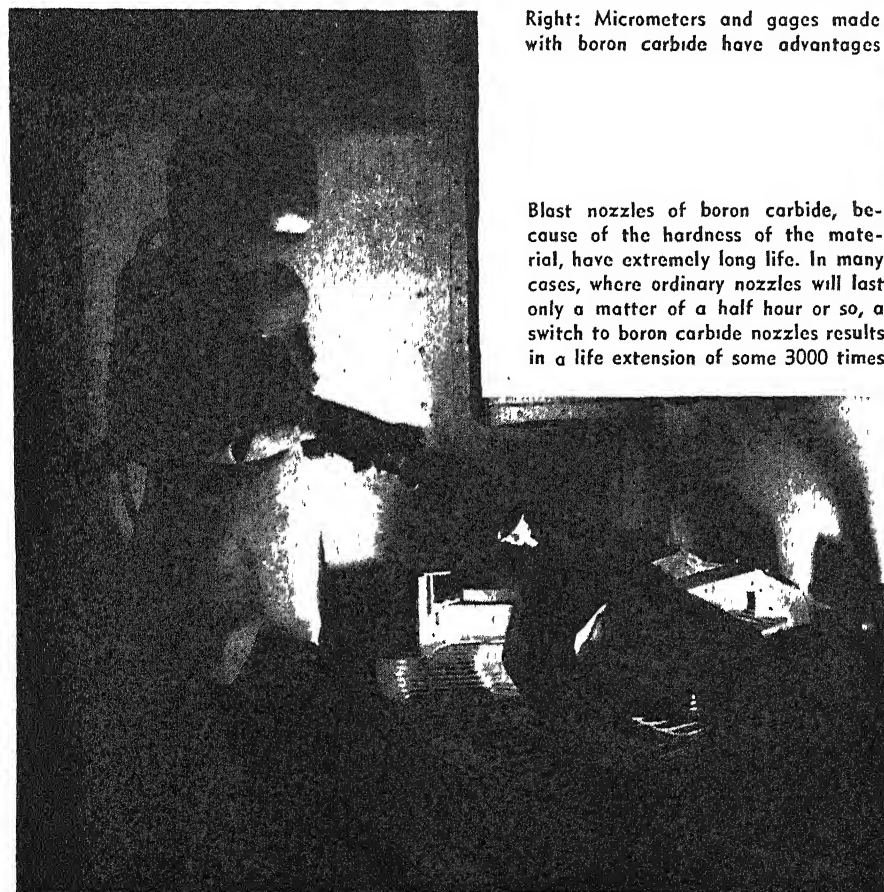
It has just one weakness. Solid boron carbide is brittle. And the individual grains that make up the solid form also are brittle. Boron carbide shapes should not be hit with hammers nor dropped on the floor. Boron carbide grains cannot

be used as the abrasive in a grinding wheel, their sharp points will break off and leave the wheel glazed and useless.

And this is the challenge of boron carbide, a challenge which has been too tough for most industrial designers to accept during the ten years or more that the material has been on the market. Fabrication always involves processes which are either deforming or destructive;



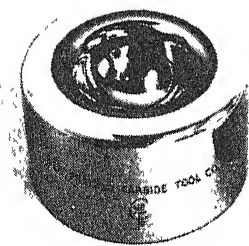
Right: Micrometers and gages made with boron carbide have advantages



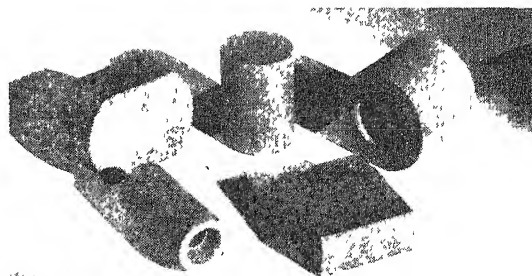
Blast nozzles of boron carbide, because of the hardness of the material, have extremely long life. In many cases, where ordinary nozzles will last only a matter of a half hour or so, a switch to boron carbide nozzles results in a life extension of some 3000 times

processes which cut away, eat away, melt away, or squeeze away some parts of the material being fabricated. Wear and other damage in service are caused by exactly the same processes. With the exceptions of cutting by diamonds and breaking by rough handling, boron carbide defies all such processes. Let industry learn how to fabricate boron carbide and to so design products that their boron carbide parts are protected against breakage, and some of the most durable products known to man can be made.

A few industrial designers and production men have met this challenge, and with startling results. The boron carbide parts often outwear the ones they displace hundreds and even thousands of times



Left: Boron carbide inserts in this mortar and pestle are held in stainless steel
Right: some of the more common shapes into which boron carbide can be formed



over. In fact, the boron carbide parts have been known to bring whole new industrial developments into being. Here are some examples:

BLAST NOZZLES—Ordinary chilled iron blast nozzles for handling abrasives are likely to last only 30 minutes in service, whereas those made of boron carbide may have 3000 times that life.

With the boron carbide nozzles, many a sand blaster has had to change his whole conception of his job. He had been used to having his nozzle start with a small orifice which delivered a small and controllable stream of sand with minimum use of compressed air, but having the nozzle rapidly wear larger at the orifice with the sand becoming less and less controllable and the air wastage greater and greater until he had to discard the nozzle. During this 30-minute period he had to accommodate his blasting technique to changes in the blast stream. But with his boron carbide nozzle the blast stream and the air consumption remain constant, hour after hour, day after day; eight weeks of 40 hours a week steady service will pass before he has to change a nozzle. His work is done more rapidly and is accordingly of higher quality.

Thousands of abrasive blasting operations are done by automatic machines today. It would have been impossible to develop some of the best of these machines if the long lived boron carbide nozzles had not been available to keep them in constant operation. The machines could not have compensated for rapid nozzle wear the way the operators of manually directed blast nozzles do.

GAGE PARTS—Gages which are used for inspecting extremely accurate metal parts are subject to many ailments. They can wear to smaller dimensions or to false shapes. The metal in them can creep or warp out of shape. They can pick up electrostatic charges which cause bits of metal or of abrasive to cling to them. They can be scratched by work-hardened steel chips or by bits of abrasive. They can scratch the

parts which are being inspected, especially if bits of metal or of abrasive cling to them.

One result of such troubles is false gaging. Another is that metal gages may have to be called in at the end of every eight hours of use so they can be checked for accuracy and for damage.

Boron carbide gage parts lack some of those ailments entirely, and have others only in much lesser degrees than do the tool steels of which gages ordinarily are made.

The boron carbide parts wear only at a fraction of the rates of steel ones. They will not warp or creep. They will not pick up or hold electrostatic charges, therefore chips or grits are not likely to cling to them. They will not scratch the work. They cannot be scratched by any steel chips nor abrasive particles.

One result of this superiority is that boron carbide gages often are called in for inspection only once for every 40 hours of service or even longer; they have been known to reduce gage inspection costs by 99 percent. Another is much lower gage life; in extreme cases, such as the gaging of rough porcelains, boron carbide gages have been known to last 4200 times as long as the gages they displaced. A third result is the elimination of false gaging which can be caused by gages wearing to false sizes or false shapes.

In spite of these boron carbide advantages, the great majority of gages are, and will continue to be, made of steel, tungsten carbide, and other materials. The boron carbide is too costly when only a few thousand pieces of a size are to be gaged, and there is no point in risking the penalties of boron carbide brittleness on easy jobs. But where the boron carbide is needed its advantages are likely to be overwhelming.

MORTAR AND PESTLE—When mortar linings and pestle tips are made of boron carbide they are not affected chemically by the materials being ground up and will not acquire scratches which might hold tiny particles of material and prevent completely clean washing. Therefore, the chemist never has

his materials contaminated by chemical reactions with the mortar lining or the pestle tip, or by previously ground materials which stayed in scratched places when he was cleaning his equipment.

Moreover, the boron carbide parts can be supplied with different surface finishes, ranging from highly polished to satin. Each of these finishes has a different coefficient of friction and therefore a different speed at which grinding can be done.

CUTTING TOOLS—Boron carbide is too brittle for use in ordinary metal-cutting tools. But it can be used on glass-bearing plastics, on porcelains, and on other materials where the abrasiveness of the material being cut is a hard problem and the shear resistance is not

BLASTING MASKS—When glass, wood, plastics, and other comparatively soft materials are to be sand blasted to produce special patterns and finishes on them, the areas which are not to be blasted often have to be masked to keep the flying abrasive particles from striking and marring them. Most masking materials are rapidly worn away and have to be replaced at frequent intervals. If the masks are of intricate or closely controlled shapes this replacement may be costly.

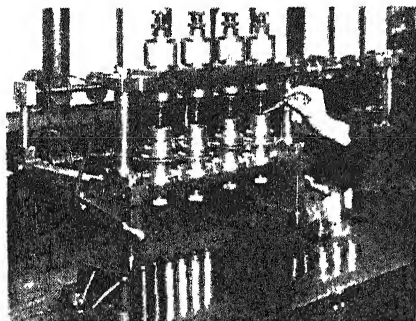
Boron carbide masks are not affected by the blasts in most cases, and when they are affected the wear is so slow as to be negligible. Their use is permitting much fancy pattern blasting which would otherwise never be attempted.

EXTRUSION DIES—Many abrasive materials are extruded to shape. Since extrusion involves heavy pressure to squeeze the materials to shape, the wear on the die can be rapid. Leads for pencils have this problem, and so do abrasive rods, coatings extruded on welding rods or on cables, and many others. The superior resistance to abrasion of boron carbide permits great savings in these dies. And not the least of the savings is in the fact that as a die wears larger it extrudes more material per lineal foot of extruded prod-

uct with consequent wastage of the material.

Other industrial parts that are subject to extreme wear exist by the thousands. The problem is to fabricate the boron carbide to the necessary shapes and sizes.

First attack on this problem is being made by the Norton Company whose Norbide is the best known commercial boron carbide. The at-



Diamond dust as a lapping agent has been replaced, in many applications, by boron carbide in the powder state

tack begins with the first steps in boron carbide production.

Norbide is made from the finest boric acid crystals combined with ash-free petroleum coke. The mixture is heated to a temperature very near to 5000 degrees, Fahrenheit, in an electric furnace. This results in cinder-like chunks of boron carbide. These pieces are ground to a

fine powder, and the powder in turn is heated to over 4000 degrees, Fahrenheit, and pressed into solid shapes. No binder is needed.

Experiments in pressing the powder into larger and larger rods, tubes, and other shapes are continually in progress. Many special shapes are made so the final diamond cutting operations will be held to a minimum.

Sometimes the pressed shapes can be used without further finishing, as is the case with some abrasive blast nozzles.

When finishing is needed for accuracy or because the shape cannot be produced by pressing a powder at such temperatures, the fabricator can learn how to do the work himself or he can turn to houses like the New England Carbide Tool Company which have made a specialty of this art. Full instructions for procedure are available, and the sales engineering behind this product is high quality, but nevertheless it sometimes is best to turn to a house which already has acquired the know-how.

Learning how to use boron carbide, and especially how to fabricate it, is difficult. But any engineer who masters that art can proceed in the knowledge that he is using the hardest material ever made by man and one of the noblest materials known to industry.

stress or pressure. Best pre-war materials lasted only 100 hours, steady improvements in the last five years have resulted in alloys that now operate successfully for 9000 hours under the same conditions.

Developed primarily for gas turbines, which are expected to find use in the future in aircraft, electric power plants, locomotives, ships, and perhaps even autos, the alloys may also find service in steam turbines, where the higher temperatures and pressures they permit will provide increased efficiency

WIND-TUNNEL STEELS

Point Way for Other Applications At Low Temperatures

THE NEW and unique sub-zero, high-altitude wind tunnel at the engine research laboratory of the National Advisory Committee for Aeronautics, Cleveland, Ohio, requires for its walls a material that is highly resistant to impact and to the embrittling effects of low temperatures, as well as easy workability and reasonably low cost

The material finally selected was one of the "low-alloy" steels (actually Youngstown's "Yoloy," a low-carbon nickel-copper alloy steel) that are also finding increased use for their weight-saving advantages in transportation and construction equipment. This newest application in low-temperature work (the temperature of the 500 miles per hour wind in the tunnel is 48 degrees below zero, Fahrenheit) suggests many possible uses for such low-alloy steels in aircraft themselves and in air-conditioning and refrigeration equipment—especially if the latter are to be portable or used in transportation equipment

POT CLEANERS

Will Use Extruded Monel Metal Ribbons

POT CLEANERS made of meshed metal strip, a war-time civilian casualty, will be made of more durable and corrosion-resistant metals when converted production really gets rolling

Dairy-industry needs led to the study of Monel metal (nickel-copper alloy) for pot cleaners, but difficulties in extruding the alloy in ribbon form and then weaving it delayed the application. With the recent solution of these manufacturing problems, pot cleaners made of this bright, non-rusting, long-lasting material are a reality, and not only Mrs. America but also whole industries (such as chemical-processing and food-manufacturing) will be putting them to effective use.

BERYLLIUM STEEL

Retains Spring Properties Up to Red Heat

A RECENTLY developed alloy of possibly interesting but still undetermined future is beryllium steel, actually a "stainless steel" containing 12 percent chromium, upwards of 8 percent nickel, and 1 percent beryllium. The alloy has high-temperature oxidation resistance but an outstanding additional advantage is the fact that the beryllium steel can be age-hardened at around 1350 degrees, Fahrenheit, and that the consequent good spring properties of the material are retained at operating temperatures up to a red heat.

HEATING ELEMENTS

Improved by Addition of Small Amounts of Thorium

GERMAN workers in the field of electrical resistance alloys of the 80 percent nickel, 20 percent chromium type (used for heating elements in home appliances and industrial electrical furnaces) recently reported

that the addition of thorium to such alloys improves their life at 2000 degrees, Fahrenheit, by 500 to 600 percent.

Thus at 1920 degrees, Fahrenheit, a wire with 0.02 percent thorium had a 75-hour life; with 0.1 percent thorium, 140 hours; with 1 percent, 325 hours; and with 2 percent, 400 hours. The increase in life seems to continue with additional thorium beyond 2 percent, but the alloys then become very difficult to work.

HIGH-TEMPERATURE STEELS

Out-Do Best Pre-War Materials Many Times Over

AMONG the most significant war-time developments from the point of view of planners of peace-time engineering products are the new high-temperature steels and alloys developed for gas turbines, superchargers, and so on.

Falling into the class of high-alloy stainless steels with special additions such as molybdenum, these modern alloys can operate successfully at 1500 degrees, Fahrenheit, and 15,000 pounds per square inch

Television In The Dark

COUPLED with other recent technical improvements, a new television camera tube recently announced by Radio Corporation of America is expected to provide television pictures that will completely satisfy the public and thus allow the carefully nursed industry to find a firm footing.

Called the image orthicon, the new tube picks up scenes by candle- and match-light, and can even produce an image from a blacked-out room in which invisible infra-red rays are being radiated. In an RCA-NBC demonstration of the new tube, all lights were turned out in the studio where the audience was assembled. Unseen infra-red lamps were turned on, but it was still so dark that members of the audience could not see one another. Television receivers in the studio were operated and their screens showed bright images of a dancer and other persons who were in the same room, yet were otherwise invisible to the audience. This was made possible by the high sensitivity of the pickup tube to infra-red rays

HOW IT WORKS—The new tube contains an electron image surface, a scanning section smaller and simpler than those built before the war, and an electron multiplier section. This latter element amplifies the relatively weak video signals be-

Image Orthicon Tube Has Tremendously Increased Sensitivity, Especially in the Infra-Red. It Points to Perfected Television and to Military Applications in Television-Controlled Pilotless Planes

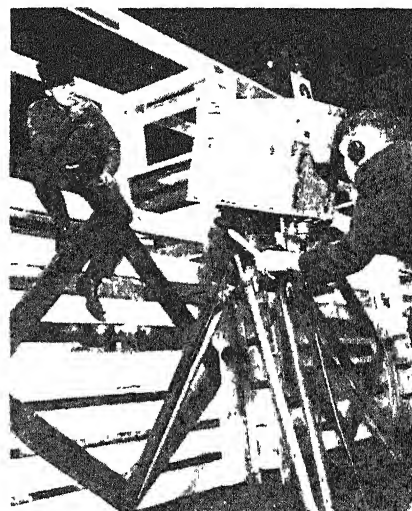
By VIN ZELUFF

Associate Editor, *Electronics*

fore transmission and is based upon principles that led to the design of the multiplier phototube. The high sensitivity of that tube depends on secondary electron emission, in which electrons are directed toward a target called a dynode. When an electron hits the dynode, two or more electrons are emitted for each electron striking it. These, in turn, can be directed to another dynode and so on through a series to provide still further multiplier action.

An optical lens system is used to pick up light from the scene to be transmitted and focus this light on a photosensitive surface in the camera tube. Electrons are emitted from each illuminated area of the surface in proportion to the intensity of the light striking the area.

A grid placed behind the photosensitive surface forces streams of electrons to flow from the back of the photosensitive element to a scanning target. The resulting bombardment causes secondary electrons to be thrown off the target and

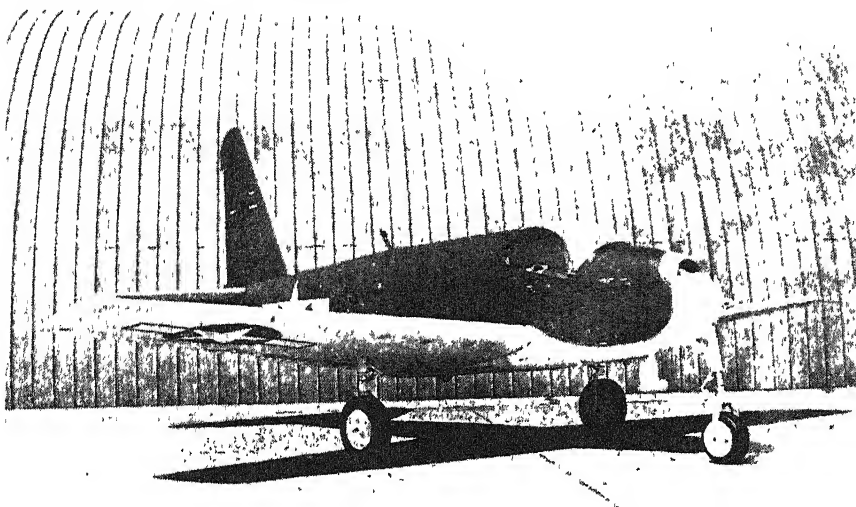


RCA's new supersensitive television camera should solve many of the illumination difficulties of the art

leaves on it a pattern of varying positive charges which corresponds to the image of the scene being televised.

A beam of electrons from a conventional electron gun in the base of the tube scans the target. Electrons in the beam slow down and stop just short of the scanning target and return to the base of the tube, except when they approach a section of the target that has a positive charge. Then enough electrons are deposited on the back of the target to neutralize the charge, after which the beam again fails to reach the target.

The returning beam thus has a varying loss of electrons left behind on the target, and the beam current corresponds with the picture information on the photosensitive surface. The beam is amplified in a cascade electron multiplier that consists of a series of dynodes near the base of the tube. On weak signals when the camera tube is illuminated by only



Official United States Navy photograph of a "Glomb"—a television-controlled glider-bomber that can "see" its target ahead and be guided to it from some remote point

andle per square foot, the multiplier has an amplification of about 100. At a 10-candle level, this value drops to about 10; this feature provides an action similar to automatic volume control in home radio receivers. This is an advantage in television since it prevents strong lighting in the scene from blotting out weakly-lit portions.

Television cameras fitted with the new tube are expected to be ready for delivery to television broadcasters in about six months. The

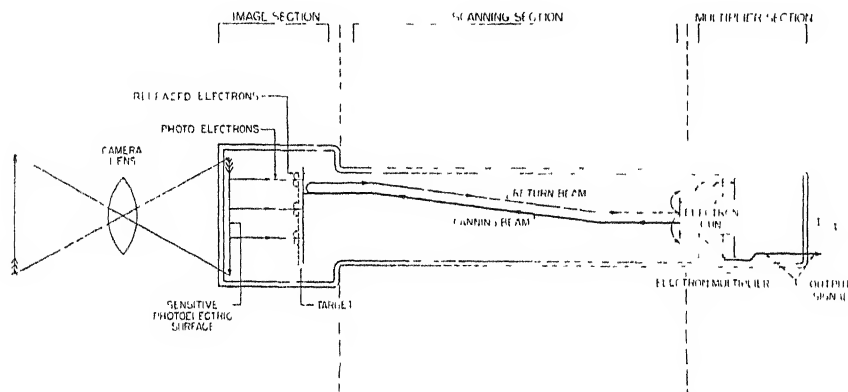
high sensitivity, it provides greater depth of field and inclusion of background that might otherwise be blurred. It may be used in conjunction with a telephoto lens for long shots.

PILOTLESS PLANE "EYES" — The image orthicon tube has been a military secret until now. Some of the uses to which it can be applied will probably remain secret for some time, but one application of television techniques that the Navy has

stroyer. Similarly, a dive bomber was made to plunge through the center of a moving target. From these experiments several types of pilotless assault ships were developed, a number of which were used against the Japanese base at Rabaul.

For such use, the television camera "sees" ahead of the guided missile and transmits the scene back to the control plane. If the missile is properly aimed, the desired target appears on the screen of the television receiver in the control plane. If the target is not visible or not accurately centered, the flying path of the pilotless plane is corrected by radio signals from the control plane or base.

According to the Navy, future wars will be fought in the air by pilotless planes that will "home" by electronics on their targets. Defense against these will consist of anti-aircraft missiles that will have an electronic brain to guide them with precision. That such missiles are entirely practical is proved by the results obtained by use of the electronic proximity fuze in anti-aircraft shells that detonates the shell only when it is in the vicinity of the target. To develop future weapons, the United States Navy's new Office of Research and Inventions has initiated the enlargement of the airborne electronic facility at the Naval Research Laboratory. About 25 percent of the efforts of the laboratory and its personnel will be directed toward airborne electronic developments required by the Navy.



Simplified drawing of the image orthicon tube. See description in text.

high sensitivity of the new tube simplifies the lighting problems of producing television programs and makes it possible to obtain clearer television images under changing light conditions than is possible using the older camera tubes.

The image orthicon is 15 inches long and three inches in diameter at its widest section. In addition to

disclosed is that of acting as the "eyes" of a pilotless torpedo plane.

As early as 1940, successful demonstrations of pilotless aircraft had been made with a torpedo plane which was radio-controlled and television-directed from a control plane 10 miles distant. The "ghost" plane's torpedo was successfully launched squarely into a maneuvering de-

100,000,000 Electron Volts

New Super X-Ray Generator Makes Possible Transmutation of Elements and Opens New Fields for Extended Research in Nuclear Physics

By JOHN MARKUS

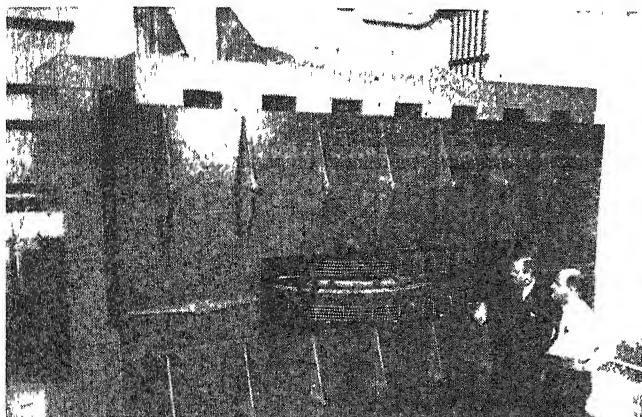
Associate Editor, *Electronics*

WITH A ROAR approximating the blast of the Queen Mary's fog horn, the hundred-million-volt betatron or electron accelerator constructed at the General Electric Research Laboratory emerged recently from behind two years of war-time censorship to show what it had been doing. Among other feats, the new electronic machine can actually create matter from energy, duplicating the process of creation of the universe from atomic particles.

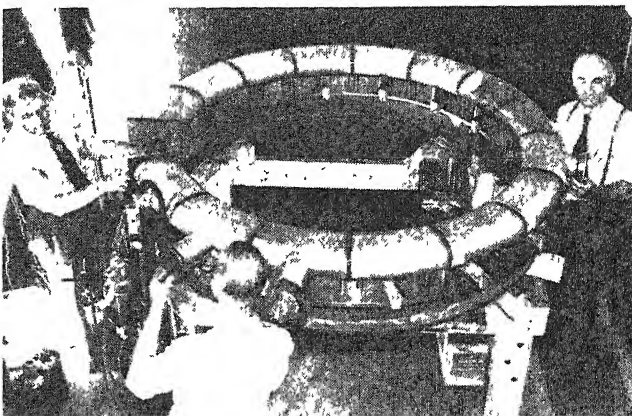
When the operating switch is closed, the 130-ton electromagnet of the unit vibrates with ground-shaking intensity, but the sound effects are incidental to the action of the magnetic field in making electrons whirl through the inside of a doughnut-shaped glass tube at a speed approaching that of light. At the critical moment, the electrons are deflected against a target, generating super X-rays of 100,000,000 electron volts that, in turn, can be changed

into newly-born negative and positive electrons—particles of matter created from energy and nothing else.

The new betatron produces X-rays far stronger than could ever be produced before, capable of making sharp, high-speed radiographs through 12 inches of steel. It is the first man-made machine that can duplicate the effects of cosmic rays. The tremendously powerful beams can even destroy the uranium atom (the active substance in atomic bombs), and can change one element to another by transmutation in a



The huge electromagnet of the electron accelerator



Doughnut-shaped glass vacuum tube of the betatron

successful though not economical realization of the dreams of alchemists.

The betatron is located in a special building with concrete walls three feet thick as a protection from the dangerous rays. The principal part is the huge electromagnet, made of laminated silicon steel arranged as a block 9 feet high, 6 feet wide, and 15 feet long. In a rectangular opening passing through the magnet from front to back are the pole faces, 76 inches in diameter, surrounded by large coils of insulated 1-inch copper conductor. These coils are energized from a bank of 24,000 volt capacitors in an upstairs room and the resultant intense magnetic field is concentrated in the 74-inch diameter doughnut-shaped glass vacuum tube positioned between the pole faces.

Projecting into the doughnut at one point is an electron gun, similar to that in a television cathode-ray tube. This gun shoots out a beam of electrons with an initial speed of several thousand electron volts. The magnetic field bends the beam into a fixed circular orbit that clears the side walls of the doughnut and boosts their speed and energy at a rate of 400 electron volts for each trip around the tube.

When the machine is operating at full power, the electrons make 250,000 revolutions and reach a speed of 100,000 electron volts in 1/240th second, after which a pulse of current passes through two smaller auxiliary coils on the pole faces. This causes the electrons to spiral away from their orbit and to hit a tungsten target which they previously missed, generating X-rays that emerge from the doughnut in a pencil-like beam only two degrees in diameter.

Einstein showed theoretically in his relativity theory that matter and energy are equivalent and that one may be changed to the other. With the betatron, this equivalence can be demonstrated and proved in both

directions. In the atomic bomb only the conversion from matter to energy is utilized. The reverse change has been observed in studies of cosmic rays and rays from radioactive elements. A small amount of matter corresponds to an enormous amount of energy, however, so only minute quantities of matter can be produced even with the expenditure of huge quantities of energy.

MATTER CREATED—The reverse process in the betatron, called "pair formation," occurs when high-intensity X-rays pass close to the nucleus of an atom. By some process not yet understood the X-rays then cease to exist and there is created instead a new electron and a positron (an electron with a positive charge). The positron quickly gets together with some other electron, so they both change to radiation. The new electron is still there, however, and, since it has mass, it is a unit of matter.

An ordinary silver half dollar gives off rays like those of radium after a few minutes exposure to the intense X-ray stream produced in the betatron, demonstrating dramatically that transmutation of elements is possible, even though expensive and impracticable. A Geiger counter is used to show the effect. The counter normally clicks about 30 times a minute, due to cosmic radiation, and the coin before irradiation had no effect. When the half dollar is inserted in the counter after being bombarded with super X-rays, the clicks step up to about 10,000 per minute. After a few minutes, however, this slows down and finally ceases, as a result of the decay of the radio-activity.

What happens is that rays from the betatron knock a neutron from the nucleus of a silver atom. This changes it from ordinary silver, with mass of 109 units, to an unstable silver isotope weighing only 108 units. The isotope gives off an electron, which increases its positive

electrical charge by one unit and transmutes it to cadmium, since it is the electrical charge of the nucleus that determines what element it is.

The electrons given off during this transmutation are responsible for the increased response of the Geiger counter. Simultaneously, another isotope of normal silver, of mass 107, changes to silver 106 and thence to palladium, and some of the copper in coin silver changes from its normal mass of 63 to 62, then to nickel. Since all of these activities die off rapidly, the coin is no longer dangerously radio-active after an hour or so. Although these changes involve huge numbers of atoms, they are exceedingly small in proportion to all the atoms in the coin, and no chemical test could detect the cadmium, nickel, or palladium produced.

Control of the betatron is entirely from a neighboring room because it is dangerous for anyone to be near when the machine is operating. An elaborate series of switches and dials enable the operators to tell what is happening.

The big machine was placed in operation in the summer of 1943 but Government secrecy orders on all work related in any way to the field of nuclear physics, designed to protect the atomic bomb project, prevented its details being revealed earlier.

✱ ✱ ✱

BIRD TRACES

Have Been Observed
On Radar Tubes

ONE possible use for radar equipment is the study of the flight characteristics of different species of birds. Albatrosses and other large birds have been found to cause spots or traces on the screens of the cathode-ray tubes used as indicators of radar units, according to a report of an ornithologist now in the Navy.

Standards For Versatility

Industrial Standards Can and Will Give the Whole World a Better Standard of Living. But Complete International Co-Operation Must be Gained Before Such Standardization Can be Fully Realized. Industry Faces Many and Diversified Problems in the Process

By EDWIN LAIRD CADY

A PHYSICIAN-SCIENTIST in New York, experimenting with the relief of pain, ran head on into an international standard. He was working with a diathermy machine, and in the process was broadcasting radio waves that by some freak of the upper atmosphere were jamming short-wave broadcasts in England and California simultaneously, although having little effect anywhere else.

He had his machine readjusted, of course, the minute he found out what he was doing. The authorities told him what steps to take, and they in turn based their instructions on international radio standards.

Problems like this caused scientists from all over the world to meet in New York a few weeks ago and do the spade-work for a brand new international standards body. They called themselves the "United Nations Standards Coordinating Committee" and they came from Australia, Belgium, Brazil, Canada, China, Denmark, France, Great

Britain, Mexico, Netherlands, New Zealand, South Africa, and the United States.

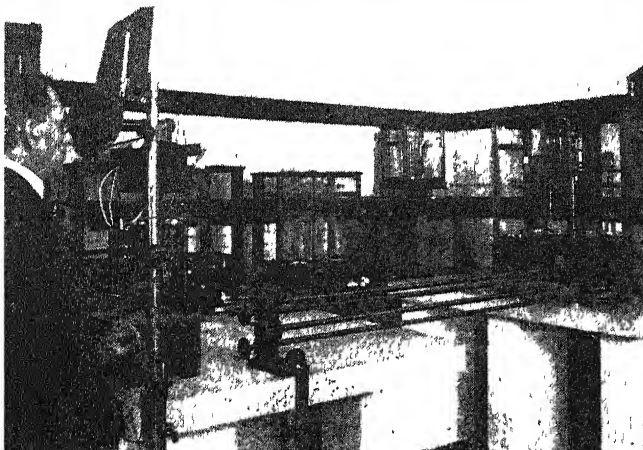
Other nations will co-operate. There will be a formal organization meeting in London early in the spring, and then or soon thereafter the whole world will have to join in. There are too many problems which recognize no national boundaries, too many situations that will not wait, for any important nation to fail to recognize the importance of standards work.

Radio is just one example. Without agreed-upon international standards, radio broadcasting stations in any nation could be made so powerful that those in other lands all over the world would be jammed off the air. A little retaliation, and broadcasting would be at an end everywhere.

RADIO HEADACHES—The question is: Where are standards which have the force or the effect of law to begin and stop? The humble vacuum cleaner is an example of the prob-

lems which cause the standards makers to scratch their perplexed heads. There is many a radar device which could enormously increase the safety of aircraft if it were not for the fact that an old and worn vacuum cleaner running in some housewife's parlor could broadcast on a wavelength that would throw the plane completely off the beam. Passing a law to control the new cleaners and other small motors as they leave the manufacturers production line would be easy enough, but passing one to control the old ones would be political suicide for many a senator, especially if the ladies did not like his radio voice anyhow! And to be much good the law would have to be international; it at least would have to get over the borders into Canada and Mexico. Enough large cities are close enough to the borders of those two nations for their vacuum cleaners to misdirect our aircraft and for ours to draw theirs' off their intended routes.

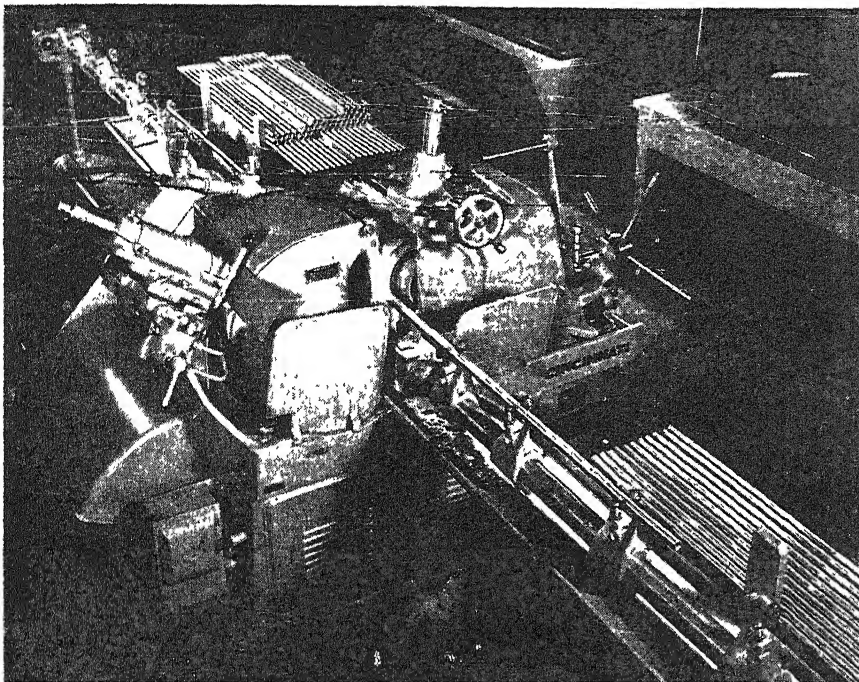
Added to this problem are wide differences in national ideas about what standards should be enacted into laws. In the United States we try to trust the force of public opinion as much as possible, to enact standards into laws only as a last result. In England and plenty of other nations the standards are matters of legislation and become laws. But, it is whispered, England



Comparing two kilogram weights. The high precision balance is accurate within one part in one hundred million



Standard gages, accurate within one millionth of an inch, are used as masters to check shop's production gages



Although a few non-standard parts give this machine tool some special motions, hundreds of standard parts make up bulk of the machine and allow great versatility of use

allows her manufacturers the latitude of "shop customs" and her actual observance of standards is less than ours. And, it is retorted, our standards for the most part are only minimum ones, and we exceed them so continually that they are likely to be obsolete before they are passed. The arguments go on from there.

Two things make Americans the standards leaders of the world. The first is that standards increase versatility of product design rather than inhibit it. The second is that standards work has to be done slowly and open mindedly, with all attention concentrated on team work.

Americans did not invent the idea of standards. Not by the stones of King Solomon's temple, the short swords of the Roman soldiers, and the bluff British threads of Whitworth. But we have gone further with their use than anyone else. And we have learned that standards are to product design what fundamentals are to football or finger exercises are to a pianist. Get the fundamentals fully under control and the original ideas work perfectly. Ignore the fundamentals and everything costs too much.

Standardized parts in automobiles get the basic costs of the cars down so low that the designers have plenty of spread between those costs and the selling prices, and with that spread they can develop plenty of new ideas. A machine tool has a new and better control motion. Everybody studies that motion, knowing that the rest of the machine is made of standard parts and

of materials tested by standard methods and that the new idea is supported by parts which are sure to function.

ONLY 800 STANDARDS—It is the standards, then, that make versatility possible at a price which the market can afford to pay. But, we have also learned, those standards have to be developed slowly. Sometimes, it seems, with exasperating slowness; our 33 years of really organized standards work under the American Standards Association have given us only a few more than 800 standards, including the war-time emergency ones.

The making of an American Standard is a tedious business. Its formal study may take anywhere from one to six years, and if anyone wishes to look back far enough into the formal development he may

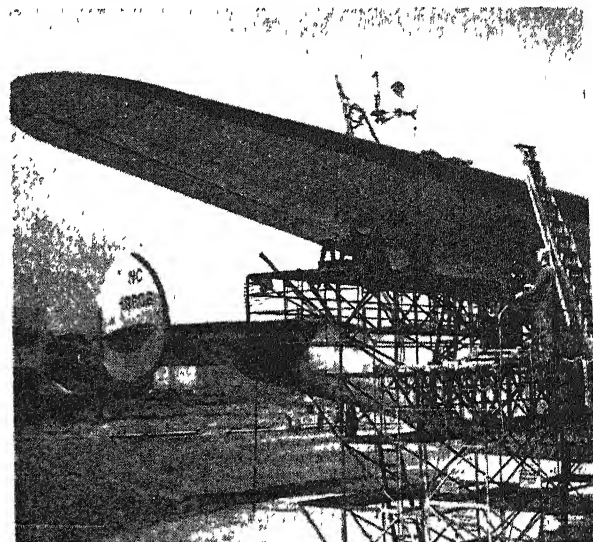
find that that part took 16 or even 60 years to emerge into standard form.

First of all, something new has to be developed and be good enough so a great many begin making and using it. The taper method of holding drills and other tools would be a good example. With time the best taper angles begin to work their way to the top of the welter of conflicting ideas on the subject, and large numbers of manufacturers begin using ones which are very nearly alike. This is the informal stage of standards development.

After a while the manufacturers feel a need to agree among themselves so that anybody's shank will fit into anybody else's socket, thus saving everybody the cost of continually making shanks or sockets of special taper angles. Some of the larger makers get together with large users, perhaps under the auspices of an engineering society such as the American Society of Mechanical Engineers. The American Standards Association (ASA) is not a formal party to this, although it may supply advice and trained secretarial help. And thus the formal part of building a standard begins.

The meeting appoints a committee and the committee works out a satisfactory tentative standard. This is submitted to the ASA and the real formal part of standardization is under way.

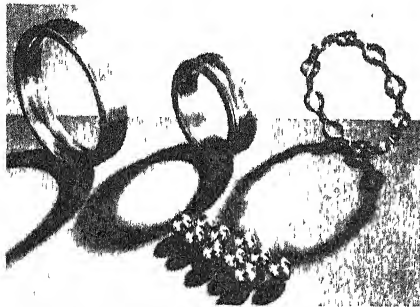
The ASA does nothing but coordinate. But there is plenty of that to be done. The National Bureau of Standards may have highly scientific ideas on the subject. Labor unions have a voice in standard after standard; their members may have their jobs and skills affected. The National Safety Council is called in; the new standard must promote safety. The air forces, the navy, and the army are important; the stand-



Circles on the ground are safety standards. No one may go within these circles when X-ray (on wing) is being used for structural inspection

and must be workable for devices in the air, afloat, and ashore. Large users are asked to vote; they may have big and costly inventories of tools or parts that will be affected by a new standard.

The standard has to be complete. A recent experience with wooden poles is an example of what can happen to an incomplete standard.



Courtesy New Departure Division,
General Motors Corporation

Ball bearing sizes are controlled
by international standardization

This one was laid down for the minimum sizes for specific strengths of poles made of the woods commonly used for this purpose. Poles of the same sizes but inferior strength woods began coming onto the market. The standard had to be revised to cover wide varieties of wood so the user could buy his poles by standard strength figures and not by size alone. This added greatly to the versatility of forest products, timber men could sell poles of woods that buyers had not previously used and could prove their values by citing the standards. But it all took time.

NEW IDEAS—Out of the chaos of conflicting opinions new ideas emerge. These are discussed with one interested party after another. The standard begins to take formal shape, often on wider and much more complete lines. The final vote is taken, and a new American Standard emerges. It often covers hundreds of items and their details may occupy more printed pages than the average shop manual. But, few items or many, it always carries the authority of agreement among highly influential parties and it always is worth following.

Some matters are progressing too rapidly for this procedure to keep up. Cylindrical fits of parts used in the automobile and aircrafts industries is one of them. For some 30 years these industries have been trying to work out standards which could be used and understood alike by all assembly lines, parts makers, repair men, and designers. But every time a new rod or sleeve comes along with new differences in thermal expansions, abilities to

lubricate, and likelihoods of wear, the cylindrical fits usages of some manufacturer or manufacturers change. Everybody sees the need for a new standard on cylindrical fits, but so many are unsure about just what to do that nobody is accomplishing anything.

In other cases standards studies are being forced by desperate situations. Men who work around highly radio-active devices may be sterilized if proper safety standards precautions are not worked out, or the men themselves may be able to procreate but their sons be born sterile. The wide spread use of the X-ray in industry, the rapid increase in the use of devices exuding noxious fumes, are other examples of situations requiring heroic measures.

Consumers' standards are being built around the "one hoss shay" idea. Rubber soled sneakers not only will be true to their size numbers, but the standard types will be so designed that the soles will wear out almost exactly as fast as the uppers instead of one part wearing out while the other still is good.

FROM ALL NATIONS—All of this work is going to be taken abroad now, tested, and widened by the ideas of men from all the other nations, and brought back to give the whole world a better standard of living. Nobody knows how much world-wide coördination can be done by just talking things over. But standards do not depend upon talk. Standards are like great ground swells of industrial and public opinion which break up old customs and allow the building of better ones. World-wide industry has learned that without standards there is little versatility and without versatility there is little industry.



PLATING TANKS

*Can Now be Protected
With Colored Coatings*

ONE TROUBLE which electroplaters have always experienced is the dark colors of most of the coatings with which the exteriors and interiors of their tanks have been protected.

Such coatings must resist temperatures up to 160 degrees, Fahrenheit, in the presence of strong caustics and of such acids as hydrochloric, sulfuric, phosphoric, and chromic. Finding coatings which will stand up for reasonable lengths of time has been problem enough without also worrying about their colors.

Now, coatings can be had in var-

ious bright colors and with highly superior resistances to the chemicals. The colors will dress up the plating room, make adequate lighting easier to achieve, permit the readier use of color codes to identify tanks and their purposes and dangers, afford color contrasts with various kinds of platings and solutions so the operators can more readily judge the qualities of the work they are turning out. The new coatings do not stain under the action of the plating chemicals, they can be scrubbed clean with clean water, and their color advantages are easy to maintain.

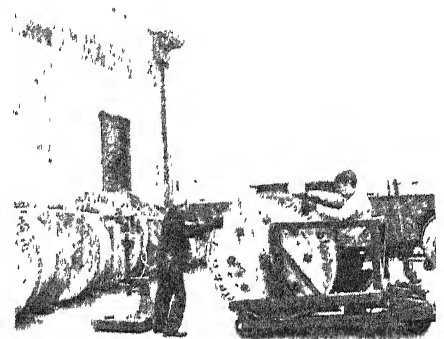
LIFT TRUCKS

*Serve Admirably as
Special Tools*

A FEW pieces of structural steel, a few hours of welding, and many a lift truck can be made into a time-saving, special-purpose tool.

Modified and amplified lift trucks are handling cable reels, dies for setting up presses, heavy forgings for mounting in lathes, rolls of paper for printing presses, barrels of oil for filling the sumps of large machines, tanks of chemicals for loading process vats, lengths of pipe or shafting for installation, precast concrete shapes for placing, and so on.

In most cases, the special equipment is permanently attached to the lift truck. But there are a surprising number of occasions on which the special device is "false work," to be used only once and then dismantled. The false work may be of lumber, it is extremely handy when install-



A special purpose lift truck applied
to handling large reels of cables

ing power transmission shafting and other cumbersome equipment overhead.

The practice of using partly worn lift trucks as special purpose tools will increase as more and more of them are retired from their present duties.

Motorless Flight

Towed Gliders, Proved in Military Uses, Are Now the Subject of Intensive Study for Future Commercial Uses. Special Jet Motors can Help to Get Them off the Ground. But the Greatest Competitor of the Cargo Glider is the Developing Type of Cargo Plane Itself

By ALEXANDER KLEMIN

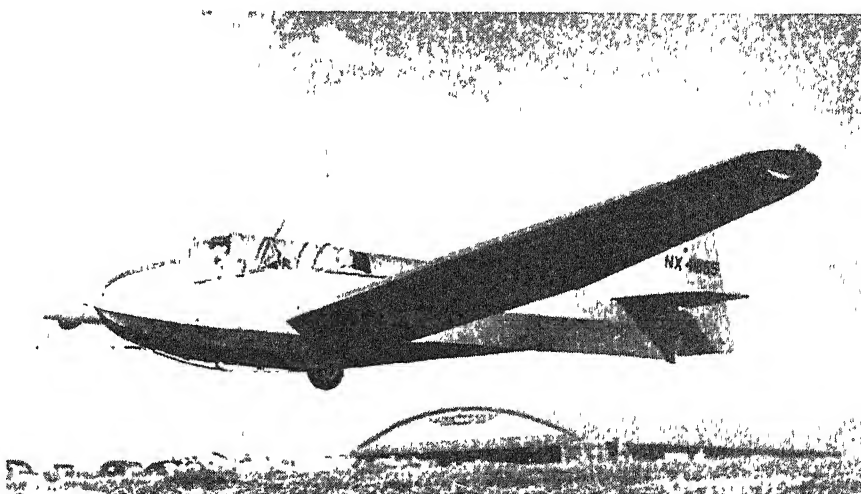
Aeronautical Consultant; Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

GLIDERS did very well during the war and served the Allies in a new method of warfare but will gliders and gliding have any importance or significance in peace? The Motorless Flight Conference, recently held at the Polytechnic Institute of Brooklyn under the auspices of the Soaring Society of America, gave answers to this question, indicated the remarkable range of activities in which the glider is concerned, and also brought to light some interesting devices and ideas.

Thus, when Howard Burr, of Schweizer Aircraft, discussed the use of a shoulder harness for glider pilots and passengers, he dealt with a topic which concerns safety in all aviation, powered as well as motorless. However well designed aircraft may become and however skilful pilots may be, there will always be crashes and head-on landings. In the case of a crash landing, the five major sources of injury are due to structural collapse, the location of the instrument panel in front of the pilot, the back of the front seat in a two seater tandem airplane, belt failures, and striking the control wheel.

When the airplane crashes on landing, a high value of forward acceleration is created. Even though the body is held in the seat by the lap safety belt, the upper part of the body and the head may be thrown forward and serious injuries or death be the result. The dangers attendant on crash landings when the lap belt is used have been confirmed by many studies.

On the other hand, when the shoulder harness has been employed, in experiments where the pilot was exposed to a forward acceleration of 8 G (which simply means eight



A towed glider leaves the ground; elastic tow line absorbs the initial shock

times the ordinary force of gravity acting in a forward direction on the body and spells 1600 pounds for a two hundred pound man) no injury and hardly any discomfort followed. Shoulder harness has frequently been used in England and Germany. There are disadvantages in the shoulder harness: more webbing and more hardware are required, and the shoulder harness is harder to fasten. But it should most certainly pass from the experimental stage to serve in gliders and in airplanes which are at all likely to be subjected to dangerous crash conditions. It is also probable that the use of shoulder harness in sailplanes will be the spear-head of more extensive use.

TOW LINES—A paper presented by Captain R. S. Barnaby, of the Philadelphia Navy Yard, on "Gliding's Contribution to the War and Vice Versa," dealt particularly with nylon tow lines connecting towed gliders and "tug" planes. This amazing ma-

terial is light and strong, has a surprising amount of stretch, and, because of its slow return or hysteresis, has the ability to absorb shock without causing surge. No wonder nylon has had to leave stockings to take up war duty! A good tow line is essential in straight flying. But the best of tow lines will not take care of blind flying, or flying at night when the glider pilot cannot see the towing airplane. Nor is the tow line primarily designed to correct for gusts nor to transmit signals for banking or turning. Hence there have been perfected automatic pilots which keep the glider in a constant position with reference to the tug. The actual character of the device has not been revealed as yet, but readers can use their imagination constructively.

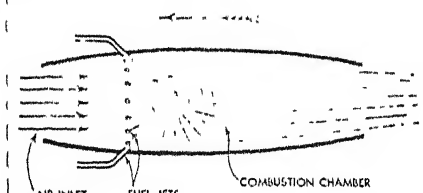
Some of Captain Barnaby's philosophy regarding "trailplanes" is as follows:

"It is easy now to cite how towed aircraft was a natural and logical development—how man had learned

early in his civilization that he could drag more than he could carry, to cite the horse drawing a wagon versus the pack-horse, the tug-boat with its tow, the auto-trailer, and, of course, the most startling example of all—the modern freight train . . . but the more I tried to draw analogies, the more confused I became. Afloat, tows are common for short hauls, but for long hauls the large single-unit ship is more common. On the road the auto-trailer is used principally for long hauls, the single unit truck for short hauls. The railroad uses the train whether the haul be long or short." Obviously, analogies are difficult to draw when considering aerial flight.

It will certainly be agreed that the glider exponents have much on which to base their hopes for a bright glider future, but the most important question discussed at the Conference concerned what the cargo glider can do in commercial operation?"

CARGO GLIDERS—To begin with, the cargo glider can help establish air transportation in China and in other regions where railways are almost non-existent and where the whole industrial future of the country is tied up with air operations.



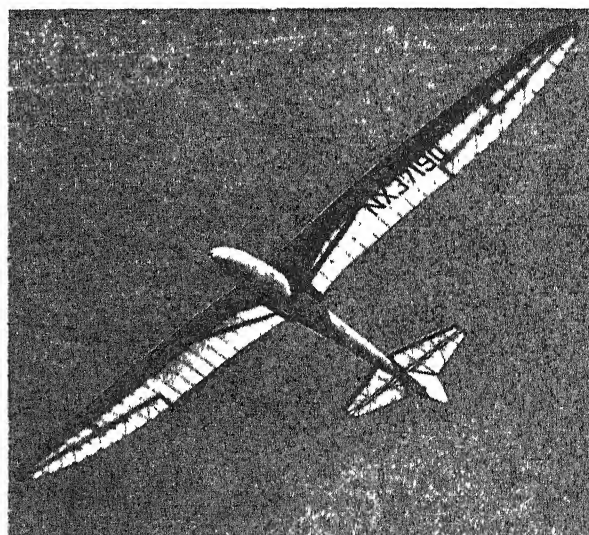
Reproduced by permission of Harper and Brothers from Fandray's "The Coming Age of Rocket Power"

The athodyd, a simple reaction type motor that may aid glider launching

Major A. E. Blomquist, of Eastern Airlines, reported that all China's essential services could be operated with a hundred large transports; that trunk line airports, within reach of cities and rivers, are available; and that the glider train would bring the benefits of air travel and cargo to hundreds of Chinese communities that are now without airports.

Major Blomquist is hopeful of the future of glider trains in China, if these trains are coupled with pick-up and delivery gear. Here is his splendid definition of the proposed service: The gliders would be designed with flight characteristics that would permit their landing in very small fields and in rough terrain. A plane like the Douglas DC-3 would be perfectly suitable for the tug; the DC-3 has been thoroughly tested in tow service. The gear for picking up gliders up to 16,000 pounds in weight has been developed and tested. The

After pick up, the glider gains altitude quickly. Note clean aerodynamic design of this glider



pick-up gear for snatching 8000-pound gliders has been in the field for some time and its potentialities have been fully realized. The same gear can be used for dead-weight pick-up.

Automatic delivery gear has been developed for use with the DC-3's. This gear permits parachute packs to be loaded prior to flight or in flight and to be dropped accurately by simply throwing a switch in the pilot's cabin or cargo cabin. The DC-3's would operate from a central point on a daily schedule, deliver mail and parcels to points on a given circuit, and do the same in pick-up.

Major Blomquist's conclusions in regard to China are not likely to be questioned. But there is much more scepticism to be encountered as regards the use of the towed glider in the United States. Thus John W. Laister, of Laister-Kaufman Glider Company, in his paper "The Development of the Cargo Glider and the Practical Post-War Outlook for It," suggested some special uses which seem quite likely. In his opinion, gliders could be used immediately in specialized applications. The Forestry Department, for example, could use towed gliders in fighting forest fires and in moving men and equipment to danger areas. Fires appear in unpredictable places, where the airplane itself could not possibly land. The moving of mining and oil-well equipment into inaccessible areas would be another ideal application for the glider.

A frequent argument for the sky train is that, because of the enormous freight load which it can carry, the cost per ton mile will be very low. There seems to be an error here, because the cost per ton mile will probably be lower for the properly designed cargo plane than for any possible sky-train combination. The sky train will be much slower; costs in aviation go down as the

speed increases—at least for many items such as pilot's pay, insurance, depreciation, and so on. And this factor holds good despite the enormous cargo-carrying capacity of the sky train.

Richard H. Rush, of All-American Aviation, Inc., was more hopeful and more specific in regard to the sky train. For a cargo glider of ten-ton payload capacity, the lowest possible operating cost will be ten cents a ton mile. Rail express moves at an average rate of 9.2 cents a ton mile. Truck freight averages 5.5 cents a ton mile. Railroad freight in carload lots goes down to one cent a ton mile. So the cargo glider would not be too far out of line on costs. Perishables such as fruits could be very conveniently carried. Materials that have to be packed in very heavy wooden containers for rail shipment would need less handling by air than by rail and hence would be a potential air-cargo market. Refrigerated freight is very well suited to cargo glider service. While Mr. Rush is hopeful about the future of air cargo via gliders, he also concedes that the cargo plane itself is the most formidable competitor of the towed glider.

ASSISTED GLIDERS—The "athodyd" is one of the most intriguing possibilities for increasing cargo-glider use. Thus Zygmunt Fonberg termed his paper "The Athodyd as a Velocity Transformer" and gave an actual demonstration of this plausible device as a means of launching gliders in a simple manner. The device is a "ram jet motor." The motor which was demonstrated was nine inches long and two and a quarter inches in diameter, and contained no valves or moving parts. It consisted of a small cylindrical pipe, which appeared to be empty. The lining of the tube tapered from an inch and an eighth in diameter at the front

end, to a large end of two and a quarter inches, in the fashion of a cone. The space on either side of the lining and the outer wall contained the fuel, which ran into a nozzle at the forward opening of the cylinder. Air rams into the cone, and mixes with the fuel coming through the small holes of the nozzle during combustion. According to Mr. Fonberg, an engine 40 inches long by 9 inches in diameter would be sufficient to launch a glider. The question arises of how efficient in producing thrust an engine would be which depends only on the ram of the air for its compression, particularly at slow launching speeds. But, in view of the German V-1 and V-2, jet engines, ram engines, and all Athodyds are deserving of careful study.

Gliding and soaring are usually thought of as sports which are conducted only in fair and clear weather. But Bob Taylor, of Schweizer Aircraft Corporation, discussed "Blind Flying" in some detail. Apparently it is perfectly possible to fly a glider "blind" in clouds, for example. Unfortunately, clouds are not yet equipped with radio beams, but Mr. Taylor gave convincing

arguments for the possibility of flying blind and soaring to great heights—provided the pilot is suitably trained for blind flying, and provided that he has at his disposal such aids as a sensitive altimeter, gyro bank and turn indicator, compass, oxygen equipment, and so on.

Another thought injected into the proceedings of the Motorless Flight Conference, by William Schweizer, was that gliders should be designed for mass production so that they can be sold inexpensively. This would be in marked contrast to the slow, handicraft methods in vogue prior to the war!

Here, then, is the conclusion as to the future of the commercial glider: In countries with few airports, few railroads, and rough terrain, the sky train should be invaluable, with China as a splendid example. Aside from military uses, the towed glider will find special applications in the United States. Its use in sky trains, with the latest devices to help, is entirely feasible in transportation, in direct competition with other methods of freight transportation, but its greatest competitor will be found in the cargo-carrying airplane itself.

the pupils in 28,000 American secondary schools have access to aviation instruction.

More than \$38,000,000 worth of surplus aircraft equipment has been turned over to non-profit schools throughout the United States since October 1944 in an AAF project and more obsolete equipment, aircraft instruments, engines, and complete aircraft will be made available to schools throughout the country.

MID-OCEAN AIRDROMES

Use Buoyant Cans to Support Landing Strip

A NEW BRITISH invention seems to remove all limitations on size of mid-ocean airports. The inventor, R. M. Hamilton, who served as Petty Officer in the Royal Naval Patrol Service. The invention is termed the "Lily" because of its resemblance to a carpet of lily leaves on a pond. It consists of numbers of buoyancy cans with hexagonal surfaces, so linked together that



A 520-foot-long "Lily," undulating with waves caused by a passing boat

AVIATION POLICY

Stresses Obvious but Entirely Sound Points

SOME valuable recommendations were made in the recent report to NPA by William A. M. Burden, Assistant Secretary of Commerce for Air, and Chairman of the Aircraft Committee of the National Planning Association. They are entirely sound. They are also such as might have been expected. It is their very obviousness and inevitability which makes them all the more valuable.

Commercial and military aircraft manufacturing complement and help one another and should therefore both be encouraged, says Mr. Burden. Military aviation is not superseded by the atomic bomb, which becomes simply another element of air power. Military aviation should not be abandoned but should receive continued support in research in sufficient production of successful types for service test purposes, in continued aircraft planning, and in production maintained at such a level as to keep the industry ready for military needs. In civil aviation, Mr. Burden says that

encouragement should be given to air transportation, domestic first class mail should be carried mainly by air, and that local inter-community services are to be encouraged. International air transport should be based on the principle of regulated competition, not monopoly.

AIR EDUCATION

Shows Rapid Advances In All Branches

A SURVEY of air education in the United States has been made by The Air Transport Association. Of course, the Association, like all trade associations, is optimistic of advances in its sphere. But making every possible allowance for over-enthusiasm, the situation still appears to be a brilliant one.

The survey points out that between five and six million persons have become air-minded through flight or ground service in the Army, Navy, or Marines. About 96 percent of colleges and universities in the United States recognize aeronautics as an elective science. At least 399 of the higher educational institutions have or will offer academic work in aviation and related fields. Half

they "give" in a controlled manner to the motion of the sea from any direction. Yet these hexagonal surfaces, because they are put in tension when linked together, create their own tension—as it has been expressed in British reports—are rigid enough to uphold heavy aircraft.

The surface of the landing strip is so flexible that it will not break up, but this flexibility is controlled by under-water dampers. It is necessary to apply more than three tons pressure to move the surface at all, and the inventor claims the "Lily" will remain usable in waves up to 36 feet from crest to crest.

This latest development opens up two possibilities: placing of a ocean seadrome anywhere, and the construction of immensely long bridges. J. S. Herbert, the mathematician who helped the inventor in his calculations, speaks calmly of a 22-mile bridge across the English channel!

Frictional Heat

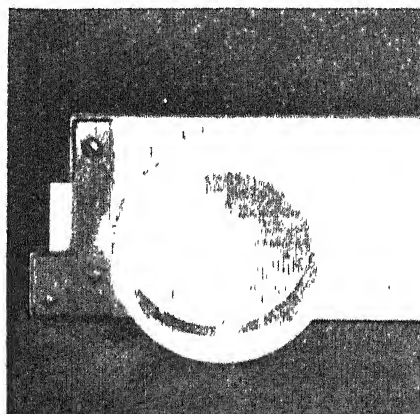
Welding, Bonding, and Molding of Plastics is Speeded by a New and Simple Process That Will Greatly Extend the Utility of these Materials in Many Applications. By Use of Friction, Plastics can be Permanently Bonded to Wood, Glass, Metals, Ceramics, and Other Non-Plastics

By CHARLES A. BRESKIN

Editor Modern Plastics

LITTLE by little the new plastics materials and processes worked out during the war are coming to light. One of the latest processes to be released from the blanket of war-time censorship involves the use of friction and the resulting heat—in welding like thermoplastics, in bonding thermoplastics and solid non-softening materials, and in localized molding of thermoplastics. Details of this development were presented at a recent meeting of the Society of the Plastics Industry by Robert N. Freres, mechanical engineer of the Rochester Button Company, the company responsible for this new use of frictional heat.

WELDING—There are several advantages to welding thermoplastic parts by this method. One of the most important is that the part welded in this manner possesses a tensile strength approximately that of the solid material; furthermore, light transmission qualities, in the case of transparent pieces, are practically unimpaired by the weld. Then, too, the weld line is remarkably clean and the slight amount of brittle flash is easily removed by buffing or tumbling. This contrasts with the hot-plate method of weld-



After the two pieces shown at right are welded together, the composite part is as clear as the original rod

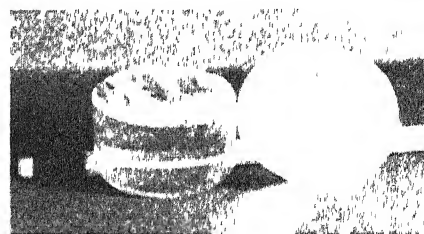
ing plastics, where a heavy flash is formed that must be ground off.

In its simplest form, friction welding of thermoplastics means generating heat at the surface by rubbing two plastics parts together and applying pressure. Because of the high speed—6000 revolutions per minute for a one-inch diameter methyl methacrylate rod—a welding temperature is reached very rapidly. The absence of air at the heated surfaces prevents heat losses, decomposition, burning, contamination, and bubbles. The fact that most thermoplastic materials are relatively poor heat conductors also acts to prevent the surface heat from being dissipated.

When the required temperature is reached, the thermoplastic material becomes soft and takes on the characteristics of a lubricant, lowering the frictional resistance. Usually the correct welding temperature is assumed to have been achieved when the softened material begins to flow from between the hot surfaces. This

displacement of material carries with it any oil, dirt, or other contamination which may have been on the surface. Thus, two pieces of acrylic cut with a hack saw can be welded together to form a clear and homogeneous part, the original rough sawed surfaces having disappeared as the material reached the welding temperature.

Pressure as well as sufficient heat

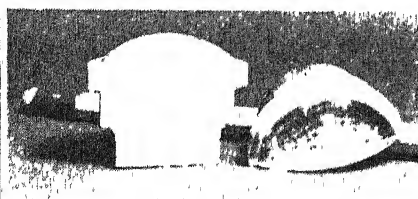


Two pieces of rough-cut thermoplastic rod prior to friction welding

is needed to bring the heated surfaces into intimate contact. However, both the heat and the pressure are applied in the same machine, pressures of about 300 pounds per square inch being applied for a few seconds.

As yet not all thermoplastic materials presently being manufactured and marketed have been tested in friction-welding, but every thermoplastic material submitted to Rochester Button Company has been successfully welded. Dissimilar thermoplastic combinations, such as polystyrene-to-acrylics, have not yet been welded but only a few such materials have been tested up to the present time.

If the materials are of the same chemical composition, there is no difficulty in obtaining a weld. Any combination of compression molded, injection molded, or cast parts can be used. Similar materials, but of



Frictional heat can also be used to bond thermoplastics to non-plastics materials. This knob cross-section shows a secure bond between a methyl-methacrylate top and a wooden base

	Solid rod 7500	Friction weld. 7200	Cemented 4170
Tensile strength, p.s.i.			
Charpy impact strength, ft lb/in. of notch	69	6.1 outer section of rod 4.8 inside section	3.1 2.1
Light transmission, total visible illuminant "C"	92.4	92.3	92.2

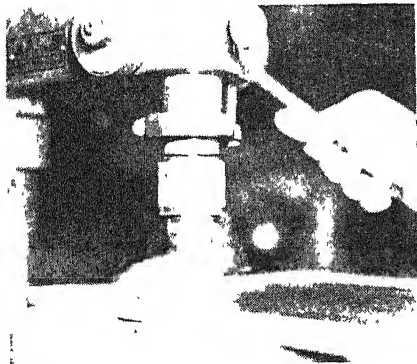
Comparative physical properties of welded and cemented joints in plastics

different colors, have a clean line of demarcation when welded together. Multi-colored parts can thus be fabricated into a homogeneous structure

Comparative tests have been made of cemented and friction-welded methyl methacrylate butt joints. The results obtained by a leading supplier, shown in the accompanying table, indicate the improvement in physical properties when welding is used.

EQUIPMENT NEEDED—Most plants are equipped with the machines required for friction welding. For example, circular parts can be welded in a drill press or lathe. Irregular shapes, however, require a reciprocating motion. A circular part is chucked in a drill press and rotated against the stationary part until the materials begins to flow and smoke at the weld line. The power is then released and downward pressure applied to the spindle. A few seconds after the motion has stopped the weld is at full strength.

The reciprocating or oscillating motion necessary for irregular-shaped articles that cannot be rotated is imparted by vibrating air cylinders, the oscillation of an ec-



Thermoplastic rods and tubes can be welded in a drill press, the pressure being applied by the spindle

centric, or other means. Even should a certain area not receive its share of the rubbing force, this will automatically be corrected. As the remaining area becomes heated and lubricated by the hot semi-liquid plastics, the normal pressure is increased on the cooler surfaces, thus increasing the frictional heat.

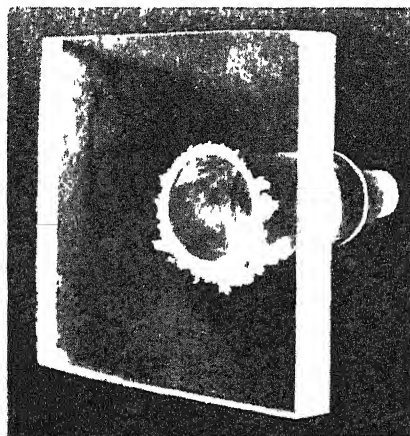
There are many applications for

this type of welding. Take optical lenses, for example. A lens of this type is often composed of several polished parts. When glass is replaced by accurate compression-molded plastics, the problem of cementing may present difficulties. On the other hand, plastics lenses have been friction-welded together in close alignment to form a transparent homogeneous whole. The operation does not affect the delicate lens surfaces because only the weld area is heated. Assembling is no longer a bottleneck; the parts are welded faster than they can be molded.

Containers that must be filled completely with liquid, excluding all air bubbles, can be welded closed while submerged in the liquid. The quality of the weld does not suffer even though the operation takes place in a liquid, and inflammable liquids can be used in spite of the high welding temperature because there is no air present for combustion.

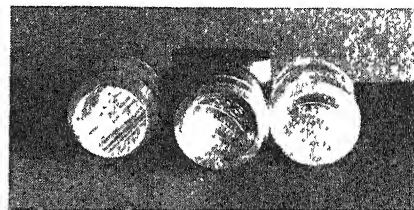
BONDING—The second use of frictional heat in plastics fabrication is in the bonding of composite structures. In this way a decorative plastics knob can be bonded to a wooden handle merely by rotating the knob against the wood until the plastics flows, and then applying pressure. Being under intense frictional heat, the plastics becomes a hydraulic fluid under pressure and transmits its pressure in all directions.

This process is particularly good



Friction welds have good transparency; the light flash is easily removed

where undercuts are involved. A hot thermoplastic, obeying the laws of a fluid under pressure, will flow into the undercuts and produce a strong mechanical bond. Should it be necessary, for example, to permanently fasten a nylon rod to one of acrylic, this could be achieved by bonding a common brass tube to the rods. The tube should have suitable undercuts, such as knurling, grooves, or notches. As it is rotated against the plastics at high speeds, the brass tube cuts its way in. When the rotation is stopped, pressure is applied, forcing material into the undercuts. The plastics, with tube bonded into it, can then be ro-



Localized molding of thermoplastics is successfully accomplished by use of frictional heat. The rough surface of the plastics (left) takes a perfect, clean impression (right) of the metal die shown in the center

tated against the second member to produce a strong permanent bond. The brass cuts its own path under frictional heat. This is not the same as forcing a hot piece of brass with undercuts into the plastic. With friction the displaced material has an opportunity to escape, producing a condition that reduces stress at the insert.

By using this principle of flowing a plastics into an undercut, any thermoplastic material can be bonded to wood, glass, steel, or ceramics, to suggest but a few of the non-plastics materials that can be thus combined with plastics.

MOLDING—The third application of frictional heating involves localized molding. In one example, a cast rod which is cut to three-foot lengths, requires a complex molded surface on the ends, but machining, polishing, and buffing would be expensive. By rotating the required mold at high speed against the rod, it is possible to mold the ends locally in a few seconds to a high polish. Heat is supplied only by friction on the surface. When rotation is stopped, the cooling cycle begins, accompanied by a pressure of only 100 to 200 pounds per square inch. The cooling is rapid since only surface heat is to be removed. When a large amount of material is to be removed, a heavy tool which is a good heat conductor should be used. Many useful applications can be

found for this localized molding process, especially in the fabrication of sheets and rods.

It would thus appear that friction, usually a factor to be combated in most machining operations, may prove helpful to manufacturers contemplating the use of plastics—particularly plastics combined with other materials.

* * *

PLASTICS DISHES

*Expedite Handling of
Food on Quantity Bases*

SPECIALLY designed plastics dishes—17 different items in all—have been introduced recently by Devine Foods, Inc. for the serving, storing, and delivery of either hot or cold foods on a quantity basis to hospitals, hotels, railroads, factories, and



Plastics compartment tray and several of the new plastics dishes with lids

so on. The entire line includes a coffee cup with handle, a cup without handle, a saucer, a coffee-cup cover, a creamer, a mixer cup, a tumbler, cafeteria tray, compartment tray, covered dishes with capacities of one half pint, one pint, one quart, two quarts, and four quarts, and a food container complete with two one-gallon dishes. Except for the cafeteria tray and the food container housing, which are molded of a Durez phenolic material, all the wares are of Melmac. The selection of this last material for all but two items—and these the ones not in direct contact with food—was the result of a long period of experimentation.

The test work was carried out, for the most part, on the food container—the first items developed by this company. Experiments were conducted with a number of different plastics compounds, and the results led to a decision to mold all dishes from melamine since this plastics is completely odorless and tasteless

and, therefore, has no effect upon food. In addition, it is easy to keep clean; the smooth surface of the moldings can be quickly washed in boiling water and requires no scouring or polishing.

Since handling problems bulk large in most establishments where these products are used, the company departed from tradition in its design for many of these plastics dishes. The cup is molded with straight, slightly slanting sides and a wide border around the drinking edge which has a thicker wall than the rest of the cup. The handle, too, is changed—flattened at the top and lined up with the top of the cup body. By virtue of this design the cups nest one within the other, and when stacked there is no tottering tower with handles slanting in all directions.

Even when filled, these cups can be stacked. The covers are grooved on the underside to fit the drinking edge. On the top is a raised section that matches the shape of the bottom of the cups. Thus, a cup may be filled with coffee, the cover put in position and another cup placed firmly on top of this cover. The Melmac serving dishes and covers are similarly designed—and for the same purpose.

PLASTICS COMPASS

*Is Economical to Make,
Easy to Use*

A REMARKABLE example of the way in which plastics can be used in a precision instrument while the price remains under the two-dollar mark is a wrist compass developed, molded, and assembled by DePage Plastics Company and marketed by Harold S. Schwartz and Associates.

Featured as an ideal gift for Boy and Girl Scouts and for hunters, campers, and sailing enthusiasts, the compass design is based on the dial-type liquid compasses that were produced by DePage for the Army Air Corps during the war. The instrument weighs approximately one ounce and consists of three Tenite II or Lumarith parts—the case (which is made of either red, white,



The complete plastics compass and, at lower left, its component parts

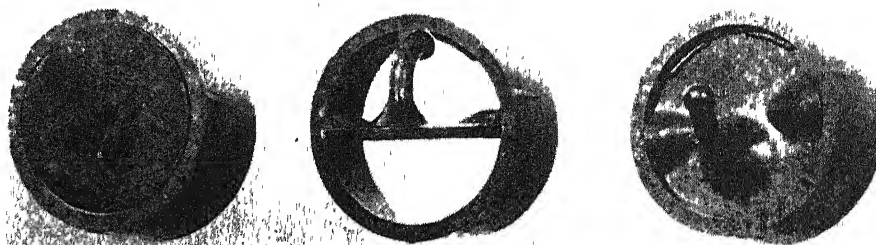
or black plastics material), the dial and the window.

Directions for using the instrument are simple. The phrase "You are looking" is stamped on the edge of each plastics base just underneath the white line that extends halfway across the transparent window. To find his directions, the user of the compass need only face this white line while holding the instrument in a level position so that the directional dial revolves easily within the liquid case. In almost no time the dial will stop. The direction in which the wearer is facing will appear at the white line.

CLOTHES HOOK

*Turns to Disappear
Into the Wall*

ONE problem of unsightly fixtures has been solved by the New Plastic Corporation, with the development of the Nupla hook which is molded of Beetle or any all-purpose phenolic molding material. This part is so designed that the center section supporting the hook turns inside the circular housing. Thus the hook can be made to disappear into the wall with but the light touch of a finger. This development is applicable to closets, doors, and automobiles. The resistance of the plastic material to the effects of humidity makes the hook ideal for use in laundries and bathrooms where steam is apt to be present.



A disappearing clothes hook made of plastics

Story of Hydroforming

THOSE gasoline fractions which are commonly referred to as naphthas and which have low octane numbers, have long been a problem to oil refiners. Such fractions have various molecular structures, but in general the normal straight-chain paraffinic hydrocarbons and a group called naphthenes characterized by a saturated ring configuration predominate. Both of these types have low octane ratings and produce knock when used as engine fuel.

Some years ago the petroleum refining industry became interested in the use of catalysts to achieve chemical transformation of these and other petroleum hydrocarbons. Research engineers knew that those hydrocarbons known as "aromatics" had an unusually high octane rating. The molecular structures of these aromatics are characterized by a hexagonal ring of six carbon atoms, well known in chemistry as the benzene ring. Therefore a search was begun for a suitable catalyst and treatment to increase the octane rating of low-grade gasolines by transforming straight-chain and naphthenic petroleum molecules into aromatic ones.

One of the pioneers in this work was the M. W. Kellogg Company, in whose laboratories initial tests were carried out literally on a half-pint scale. A number of small units were set up consisting of catalyst containers through which oil vapors could be passed and from which the resulting product could be withdrawn. Hundreds of catalysts and dozens of oil stocks were tested under various temperatures, pressures, and atmospheres. Natural or straight-run gasolines, with an octane rating of from 20 to 50 and containing practically no aromatics, were used in these initial tests. Types of gasoline from leading American petroleum producing fields were included. In the course of the tests, successively better catalysts were developed. The researchers eventually determined that a mineral known as molybdenum oxide, when dispersed in activated alumina and used as a catalyst in an atmosphere of hydrogen under certain tempera-

Research Engineers in Efforts to Improve the Engine Performance of Low-Grade Gasoline Discovered an Inexpensive and Unlimited Source of Toluene and Other Aromatic Compounds. Useful in War, They are Also Raw Materials From Which Many Industrial Products are Manufactured

By LUTHER HILL

Director, Process Engineering Department, The M. W. Kellogg Company

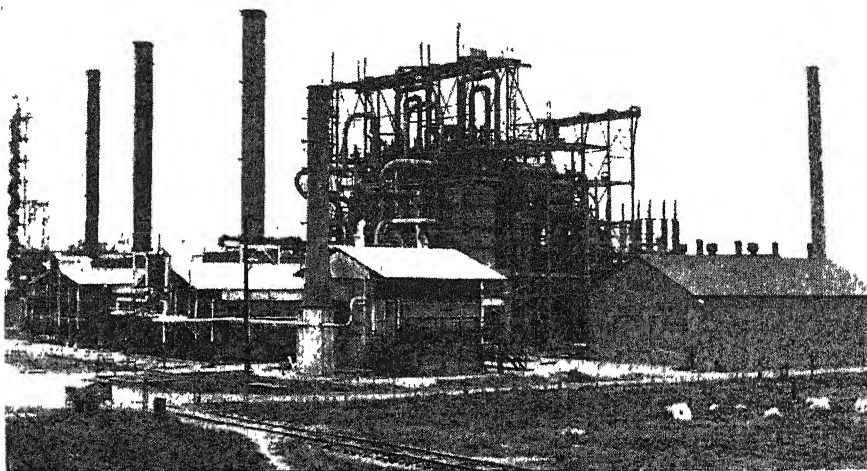
tures and pressures, altered the molecular structure of the low-grade gasoline molecules most effectively. This new catalyst changed about 50 percent of the molecules into benzene-ringed or aromatic molecules. Tests showed that the octane rating of many low-grade gasolines was almost doubled by the catalytic treatment.

Because this reforming reaction (technically called dehydrocyclization), took place in an atmosphere of hydrogen, the term "Hydroforming" was coined for the newly discovered process. The liquid product, which contained over 50 percent by volume of high-octane aromatics, was termed "Hydroformate."

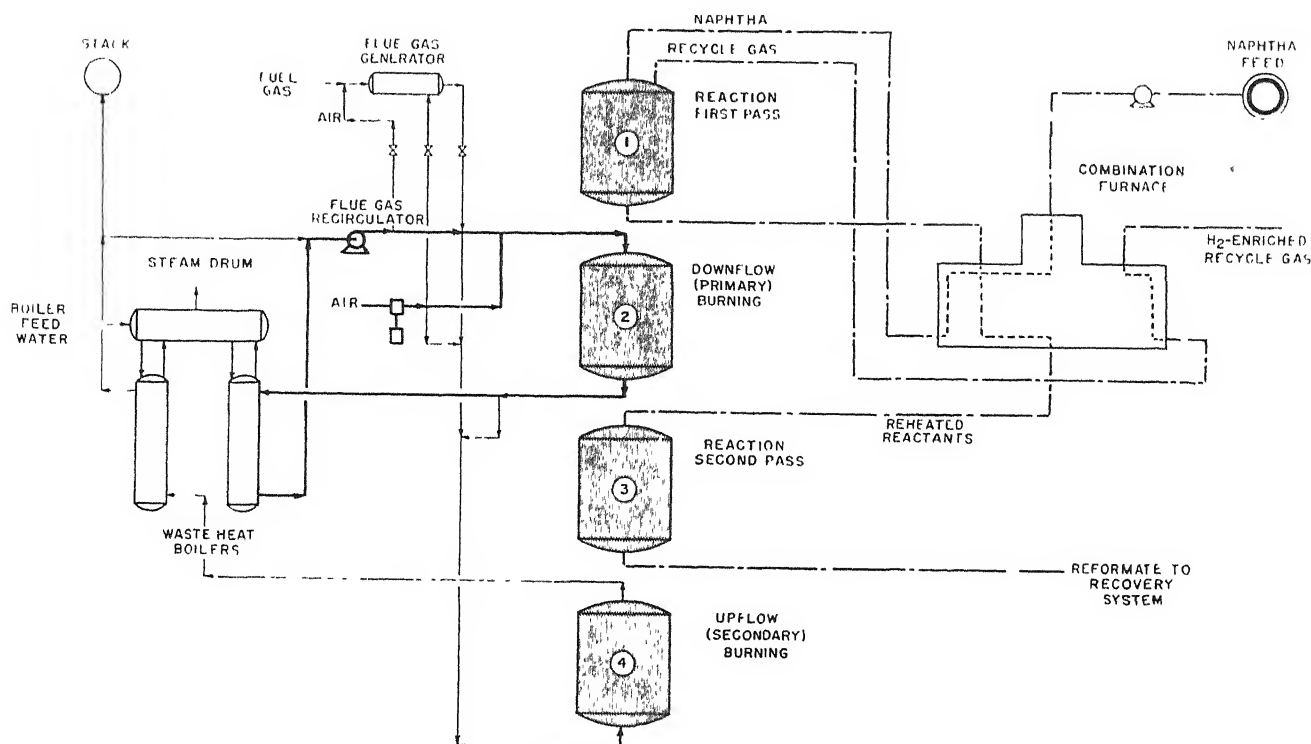
AVIATION GAS—Development advanced swiftly through the laboratory to the pilot-plant stage, with four major oil companies contributing technical data. These companies were Shell Oil Company, Standard Oil Company (Indiana), Standard Oil Company of New Jersey, and

Pan-American Refining Corporation. By 1939 the process was ready for commercial application. Designed and constructed for Pan-American by the Kellogg company, primarily for gasoline production, the first commercial unit went "on steam" in 1940.

It was found that, in addition to increasing the octane rating of the low grade gasoline, Hydroforming had three other advantages. First, it had the effect of desulfurizing naphthas almost completely, a feature which not only removed a corrosive element from the resulting motor gasoline but also enhanced the susceptibility of the product to "leading." Second, because the product contained almost no olefins or hydrogen-deficient compounds, it was unusually stable, and could be blended directly into finished gasoline. This stability, which minimizes formation of gum in the engine, is one of the most important properties required of a high-grade motor fuel; it is the gum resulting from fuel combustion which, among other



Hydroforming unit of the Humble Oil and Refining Company

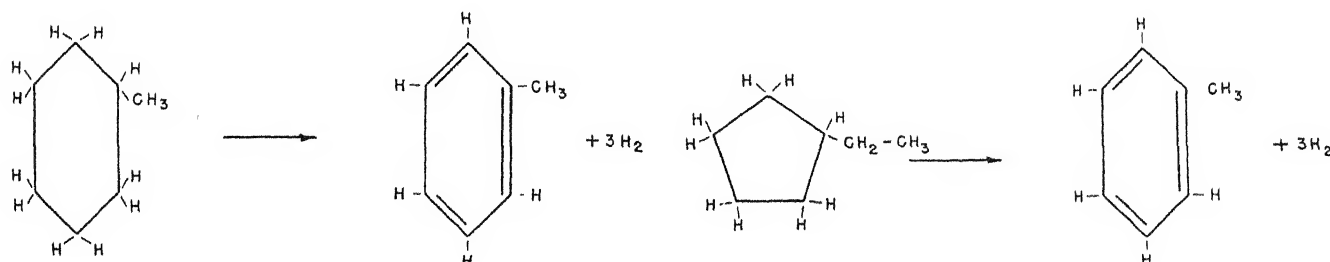


Simplified Flow Diagram of The Hydroforming Process: Low grade gasoline or naphtha feed is heated to reaction temperatures, first by heat exchange with the products and then by a furnace. At the entrance to the reactor the hot vapor is joined by recycle gas which may contain 40 to 80 percent by volume of hydrogen, depending on the feed stock, catalyst, and conditions of operation. The combined stream passes through one of the reactors (1) where the catalyst is disposed and where dehydrogenation and partial conversion takes place. Reaction products are then reheated and pass through a second stage (3) where some cyclization and hydrogenation occurs.

Products are then cooled and condensed and the gas is separated

from the liquid. Some of this gas is recirculated while the remainder is released as necessary to maintain the desired pressure on the system. The liquid product is stabilized by removing the lighter hydrocarbons and further fractionated to eliminate a small percentage of high-boiling polymers

In spite of the fact that coke formation is quite small it is necessary to regenerate the catalyst at regular intervals. To permit continuous operation, four reactors are provided, two of which (2 and 4) are regenerating while the other two (1 and 3) are on reaction. Regeneration of the catalyst is accomplished by burning off the accumulated carbon by means of air diluted with spent regeneration gas



An example of dehydrogenation occurring in the Hydroforming reaction. The ringed molecule at the left is methyl cyclohexane, a typical naphthenic hydrocarbon of low octane rating. Toluene, at the right, is obtained by knocking off hydrogen atoms to produce an aromatic hydrocarbon

Another naphthenic hydrocarbon, ethyl cyclopentane, is pictured at the left. In Hydroforming to produce toluene (at the right), not only does dehydrogenation occur but the carbon atoms are rearranged so that a six-membered hydrocarbon ring is obtained from a five-membered ring

things, causes valves to stick, piston rings to clog, carburetors to plug, and which impairs the efficiency of other parts. Third, it provides, as a by-product, a gas which is rich in hydrogen. Hydrogen is expected to be an important raw material in many future operations as, for example, the production of ammonia from air and the preparation of cooking fats from fish oils.

Hydroforming, by changing the molecular structure of low-grade gasolines, guaranteed our war-time airplanes and those of our Allies vast quantities of high-octane gasoline,

far superior to any in use by the enemy, and at reasonable cost.

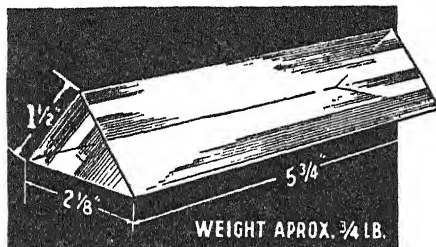
TOLUENE—The story of Hydroforming is an outstanding example of how research in one field not only accomplished its initial purpose but also uncovered a second important field.

In routine analysis of the high-octane Hydroformate, chemists discovered that the product contained from 15 to 25 percent of toluene by volume. By using selected petroleum fractions as feed material, the toluene yield could be maintained

close to the maximum, that is about a quart of toluene could be obtained from a gallon of gasoline. Crude petroleum contains on the average about 0.5 percent toluene.

Toluene, used commercially for the manufacture of TNT (trinitrotoluene), the major high explosive for bombs, shells, and mines, had heretofore been obtained as a by-product of the coke industry. In normal times, coke-oven toluene had been ample for the requirements of the solvents, synthetic dye, and explosives industries, but after Pearl Harbor that source hadn't a ghost

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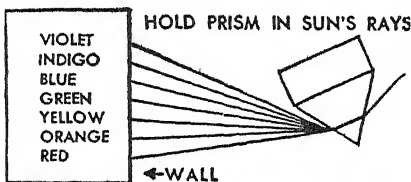
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3042-S	Right Angle	41 mms	10 mms	1.00
3045-S	Right Angle	70 mms	168 mms	8.00
3001-S	Lens Surface	20 mms	14 mms	2.00
3009-S	Porro	52 mms	25 mms	1.00
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of a chance to keep pace with the tremendous amounts of military toluene required. Being a by-product of coke-oven operation, toluene production was geared to the steel industry's demand for coke. More coke-ovens wouldn't solve the problem, even forgetting the cost, because less than half a gallon of toluene can be produced from a ton of coal.

Since approximately one quart of toluene can be produced from every gallon of Hydroformate, *two gallons of low grade gasoline could thus yield more toluene than a ton of coal*. It therefore became evident that one good-sized Hydroformer could supply more toluene than the entire American coke processing industry. The facts were clear and the Government acted promptly. The Ordnance Department in 1941 contracted for the construction at Baytown, Texas, of a large Hydroformer to be operated by the Humble Oil and Refining Company for the specific production of vitally needed toluene, with high-octane gasoline as a secondary consideration. This unit was the nation's first Hydroformer designed and constructed for toluene production.

From that point on, the petroleum industry's total Hydroforming capacity rose rapidly. By 1944 eight Hydroforming plants were in operation with a total naphtha feed capacity of 21.7 million barrels yearly, capable of producing over five times as much toluene as the total production from all other sources. All of these plants were devoted primarily to toluene, though their contribution to the high-octane gasoline program amounted to hundreds of millions of gallons.

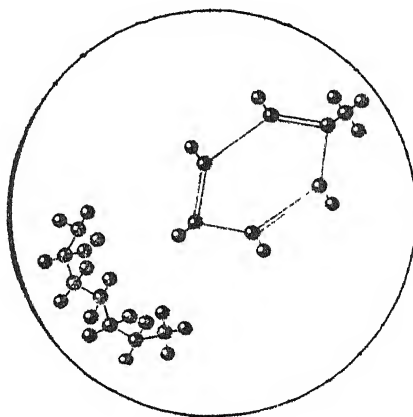
Certain straight run and natural gasoline fractions contain varying amounts of methyl cyclohexane, ethyl cyclopentane, and dimethyl cyclopentane, three members of the naphthenic group, whose molecules each contain seven carbon atoms, the same number as toluene. As indicated by the prefix "cyclo," these naphthenic molecules are characterized by a ring configuration and as a result contain two less hydrogen atoms than the straight-chain paraffinic molecules of the same number of carbon atoms. All are readily converted to toluene in the Hydroformer.

For commercial toluene production the naphtha is first prefracted into a narrow-boiling "cut" (190 to 260 degrees, Fahrenheit), in which are concentrated all of the C-7's originally existing in the naphtha. During the war, most of the major oil refineries co-operated in the preparation of this "heart cut"

and shipped concentrates to Hydroforming units scattered over the land.

The overall yield of toluene based on the naphthenic constituents of the concentrate is greater than 100 percent, showing that, in addition to quantitatively converting the naphthenes to toluene, the Hydroformer also converts some other part of the concentrate to toluene.

The toluene is separated in a re-



These molecular models show how, in Hydroforming, a straight-chain hydrocarbon molecule having zero octane rating is converted to a ringed aromatic compound (toluene) by the action of a catalyst, high temperature, and pressure. The process is known as dehydrocyclization or cyclization

covery plant which is a separate unit from the Hydroformer. By an efficient system of heat exchange it is possible to provide all of the heat required to operate this plant by exhaust steam from the Hydroforming section, which contributes materially to the low cost of the resulting toluene.

Another outstanding feature of the recovery unit is the unconventional method evolved by the Shell Development Company, of separating toluene from compounds close to it in boiling point. Ordinary distillation techniques would require a prohibitive amount of equipment to separate the toluene from its close-boiling neighbors. However, by the use of phenol, the volatility ratio of the toluene and non-toluene hydrocarbons is changed so that their separation can be effected with an economical set-up. The phenol leaves the processing column with the toluene and is separated by ordinary distillation in another column from which it is returned to the original column.

It must not be forgotten that the Hydroforming process is a flexible one. If, for example, high-grade motor fuel instead of toluene is the desired end product, the naphtha, without any preliminary treatment, is fed directly into the catalytic re-

actors. A clear, stable, 80-plus octane fuel containing over 50-percent aromatics is then obtained which is very susceptible to leading; the addition of only one cubic centimeter of tetraethyl lead per gallon of this Hydroformed gasoline gives a five-point increase in octane rating.

In addition, Hydroforming has attractive possibilities for use in the preparation of basic materials for many chemical industries. By altering the Hydroformer feed to include primarily those compounds having only six carbon atoms, benzene may be produced; by using molecules of eight carbon atoms, the production of xylenes and ethyl benzene is possible. From toluene and these other aromatic compounds can be manufactured such products as synthetic rubber chemicals; various plastics, including the styrenes; phenol and phthalic anhydride; medicinals such as saccharine and aspirin; paints, lacquers, and dyes; photographic developers; water-proof finishes for textiles; linoleum; dry cleaning chemicals; glues and cements; ink, artificial leather; perfumes; insecticides; preservatives for canning, paper sizing chemicals; resins; and many other products. The result is that Hydroforming gives more complete integration to the refiner and producer of crude oil. Not only can they now get "the last squeal out of the pig" by producing more gasoline and a greater number of useful products from a barrel of crude oil but the supply of petroleum is thereby conserved. Certainly the process offers attractive applications in industry by proving that crude oil is the most prolific and versatile raw material for the rapidly expanding chemical industry

* * *

GAS STATIONS

Will Feel

Effects of Research

SERVICE stations of the future will be built along strictly functional lines, and will market a far wider variety of merchandise than most stations have ever marketed before, according to the Shell Oil Company, Inc.

The new stations, as visualized by Shell, will be a product of more than two years of research and study on the part of marketing experts and service station dealers, working with industrial designers and guided by public preference as ascertained in a survey of 180,000 motorists.



Now - MATCH THEIR BEST WITH YOUR MOST IN THE VICTORY LOAN!

Top off your good work on your Payroll Savings Plan with an outstanding showing in the Victory Loan—our last all-out effort!

Help bring our boys back to the homes for which they

fought—and give our wounded heroes the best of medical care—by backing the Victory Loan! You know your quota! You also know by past war-loan experience that your personal effort and plant solicitation are required to make your quota.



Sell the New F.D. Roosevelt Memorial \$200 Bond through your PAYROLL SAVINGS PLAN!

In rallies, interdepartmental contests, and solicitations, promote the new Franklin Delano Roosevelt Memorial \$200 Bond! Better than "cash in hand," Victory Bonds enable the buyers to build for the future—assure a needed nest egg for old age.

Keep on giving YOUR MOST to the Victory Loan! All Bond payroll deductions during November and De-

cember will be credited to your quota. Every Victory Bond is a "Thank You" to our battle-weary men overseas—also a definite aid in making their dreams of home come true! Get behind the Victory Loan to promote peacetime prosperity for our returning veterans, your nation, your employees--and your own industry!

The Treasury Department acknowledges with appreciation the publication of this message by

Scientific American



This is an official U. S. Treasury advertisement prepared under auspices of Treasury Department and War Advertising Council

Microwaves On The Way

Extremely Short Radio Waves Made Possible the War-Time Miracle of Radar. In Peace-Time, These Same Waves Will Bring New Impetus to Television as Well as to Radio Telephony, Telegraphy, and Facsimile. Microwave Beams Can Change Our Whole Communications Pattern

By HARLAND MANCHESTER

ONE NIGHT during the final days of the campaign in Germany a young fighter pilot, lost in celestial soup and nearly out of gas, radioed an appeal for help. An operator at a newly captured airfield picked up his plea.

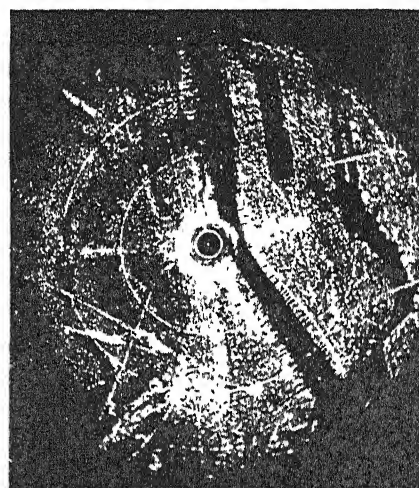
"We've got some new radar here," he said. "Just follow directions and I think I can bring you in. You are now 800 feet up. Turn three degrees to the right and keep coming."

In a truck jammed with radar equipment and personnel, the operator watched a little blip of light on a graduated fluorescent screen. That blip indicated the position of the lost fighter plane. A slowly revolving dish-like antenna, mounted on the roof of the truck, was sweeping the sky with tiny invisible waves

With every revolution, some of them hit the lost plane and bounced back, making the blip on the radar screen which showed the plane's exact position. As the plane came closer, a second operator, watching the blip on a more finely scaled screen which showed details of the airfield, took up the coaching. Slowly the plane moved downward, until the roar of motors was heard outside. The plane had landed safely.

Then someone pounded on the door of the truck. It was the fighter pilot. "Show me this new radar!" he demanded. "I couldn't see the ground at all, just felt a bump."

This Ground Controlled Approach radar, which later at Iwo Jima "talked down" many crippled B-29s to safe landings, is only one of an

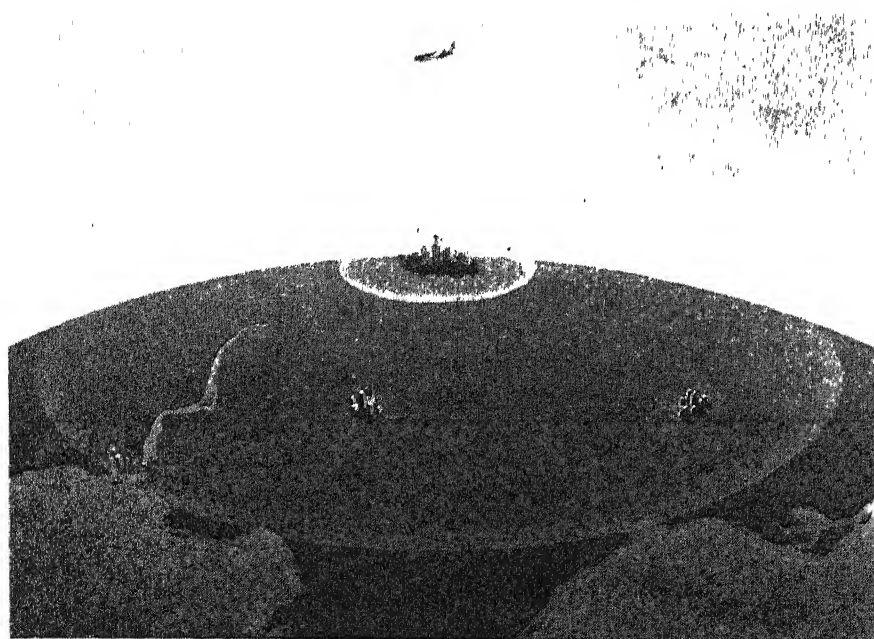


Courtesy Radiation Laboratory, M.I.T.

How radar "sees" New York City and surrounding areas. Rivers and docks are plainly discerned. At time photo was taken, the plane was directly over the dot in the center of the circle. Distance is indicated by the concentric rings around center

array of revolutionary war-time radar devices based upon ultra-short radiations called microwaves. Behind the curtain of censorship during the war years, hundreds of American and British physicists have been pushing radio upstairs into these new high frequencies. Their work makes possible things that were unheard of at the time of Pearl Harbor.

Some idea of the nature of microwaves may be obtained by comparing them with the waves which bring in your home radio programs. Suppose you are tuned to a 660-kilocycle station; when the crest of one wave reaches your receiving set, the next crest is more than a quarter of a mile away. But microwaves may be only a few inches long, with billions of vibrations a second instead of the mere hundreds of thousands in the broadcasting band. By means of these tiny waves, enemy planes have been sharply identified at distances of 200 miles. German rockets have been spotted and shot down by radar-directed guns, bombers have pin-pointed factories through cloud and mist,



Courtesy Westinghouse

Airplane television relay stations may extend the horizon of microwaves

warships have sunk enemy craft miles away in the dark, and even approaching thunderstorms have been detected hours before the first rain-drop hit the roof of the radar building.

MULTIPLE USES—In peace-time, microwaves are slated for an even more spectacular career. Several networks, now being constructed to carry them, promise these amazing things: Private phone calls by the hundreds of thousands sent simultaneously over the same wave band without wires, poles, or cables. Towns where each citizen has his own radio frequency, over which he can get voice, music, and television, and call any phone in the country by dialing. Complete abolition of static and interference from electrical devices and from other stations. A hundred times as much "space on the air" as is now available in the commercial radio band. A high-definition and color television network to cover the country. And, perhaps most important of all, a nation-wide radar network, geared to television, to regulate all air traffic and furnish instantaneous visual weather reports to airfields throughout the land. By such a system, every aircraft over the United States or approaching it could be spotted, identified, and shown simultaneously on screens all the way from Pensacola to Seattle.

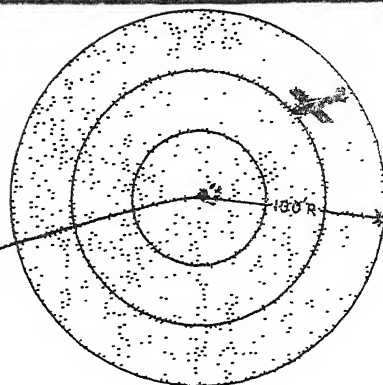
Not all these things will come at once, but war-time research has made them all possible and some will be here before we know it.

The nerve center of the great microwave development has been the Radiation Laboratory at Massachusetts Institute of Technology, established in November, 1940. From its war-time staff of 3800 scientists, engineers, and assistants—estimated to include about 20 percent of the nation's top-ranking physicists—came most of the fabulous electronic eyes which enabled the United Nations to outpoint the Axis on land and sea.

Radar was in its crude pioneering stage when this laboratory began work. Scientific explorers knew that tiny radio waves in that part of the spectrum near visible light had curious traits of behavior. They cannot ordinarily travel beyond the horizon, as can the waves from a commercial broadcasting station. Since they are near the spectrum's band of visible light, they behave somewhat like light. Microwaves are stopped and reflected by solid objects, and when a mountain or building stands in the path of their beam, a "radio shadow" is cast by the obstacle. They will not follow

A SECRET NO LONGER

*Jefferson's part
in
Connection
With*



RADIO PROXIMITY FUZE Now Can Be Told

The veil of secrecy that shrouded one of the most important factors in the war just past, can now be lifted. This development, the Radio-Actuated or Radio Proximity Fuze, has been placed second only to the Atomic Bomb in importance and scientific development.

In one of the darkest moments this Fuze halted the German drive in the Belgium counter attack, helped break Jap air power in the Pacific, and in England finally stopped the buzz bombs that Germany frantically released prior to the end of the European War.

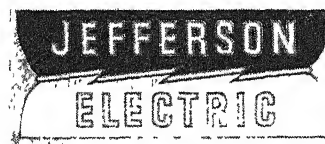
Jefferson Electric's contribution in connection with this device can now be revealed. Also credit, which was withheld due to the utmost secrecy of the project, now can be given to the skilled and loyal workers, and the inventive genius of the engineers and production experts who worked so untiringly.

One of the vital requirements was a safe operating switch that would insure against detonating the shell as it left the gun but still operate at the precise moment desired. The time between leaving the gun and firing in most instances is measured in tenths of seconds. Improper timing in the fuze of a shell results in premature detonation, commonly referred to as muzzle bursts, and is hazardous to the gun crew.

No less than 12 classes of mercury switches (all smaller than a seamstress' thimble) were made to suit the various types of guns in which Radio Proximity Fuzes were eventually used. While developing these sensitive, small mercury switches was a major accomplishment—the mass production to high standards of uniform quality and accuracy was, if anything, a greater feat. This proved again Jefferson Electric's manufacturing skill, producing—as with its transformers, ballasts and fuses—to fixed high standards at mass output rates.



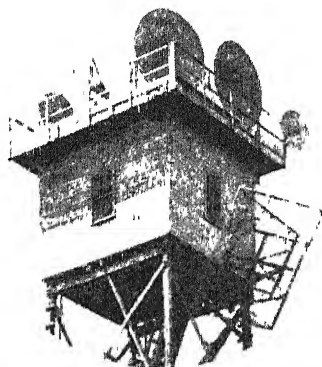
Because of the secrecy of the entire VT Fuze project, the Navy "E" Award for excellency was withheld lest it draw unnecessary attention to the plant. Now the Award with 3 stars has been made.



JEFFERSON ELECTRIC COMPANY • 916-25th Ave., BELLWOOD, ILLINOIS
In Canada: Canadian Jefferson Electric Co. Ltd., 384 Pape Avenue, Toronto, Ont.
PIONEER TRANSFORMER MANUFACTURER

an open wire in the transmitting station, but have to be sent through pipes. And while broadcasting waves travel in all directions from the antenna and can be directed only to a limited extent, microwaves can be bunched by a parabolic reflector and sent out in a sharp beam like that of a searchlight. Microwave communication is practically free from static, because the long waves of both natural and man-made static disturbances are literally tuned out.

MAGNETRONS — The tremendous possibilities of microwaves have long been recognized, but equipment



An antenna installation for the pulse time modulation multiplex radio relay system developed by the Federal Telephone and Radio Corporation as a new method of handling microwaves

to make use of them was lacking. The radio world was waiting for a new kind of tube which would generate waves no longer than a cigarette, that could be beamed powerfully over great distances. The answer came with the "magnetron," a deceptively simple-looking device which must be ranked among the greatest of war-time inventions.

This metal gadget, in some sizes small enough to fit the palm of the hand, was developed by physicists at the University of Birmingham in England, after other nations had failed in attempts to perfect a similar tube. One of these tubes was brought to this country early in the war.

In the hands of Radiation Laboratory's corps of scientific shock troops, working with engineers of the Bell Telephone Laboratories and other firms, the magnetron soon became the heart of modern radar. The exact manner in which the magnetron does its job can be described only in the language of higher physics but its most significant feature is a series of keyhole-shaped cavities in the metal collar which surrounds its source of power. A stream of electrons, shooting past these holes, sets up high-frequency vibrations, something like the way air blown through a whistle with a small cavity creates

shrill, high-pitched sound waves. These tubes produce waves as short as one inch, which can be accurately directed in a narrow, pencil-like beam. They generate short pulses of energy at the rate of 2400 horsepower — about half that of a steam locomotive.

Nearly all the radar devices which shortened the war and saved lives by the tens of thousands depended upon these powerfully beamed microwaves. This mighty but supersensitive tool brought new uses. For instance, when Dr. Donald Kerr, of the Radiation Laboratory, was testing a radar set on the roof, in March, 1942, he got "nuisance echoes" in the form of vague, fluffy images on the screen which could not have been caused by planes or other solid objects. Kerr was convinced that these images indicated rain-filled thunderclouds, and he told the Army Air Forces about it. Aumen proved his theory by personal visits to the anticipated thunderstorms, and soon the Army was using microwave radar to spot oncoming storms in Panama and the Pacific. A new aid had been discovered for safer air travel.

Months before peace came, several of the country's biggest communications and electrical manufacturing firms had applied to the Federal Communications Commission for permission to set up relay networks to transmit television, static-less radio telephone, facsimile, air-safety data, and anything else that can be heard or seen at a distance. Several such networks are now being built by various companies and there is a land rush for suitable mountaintops where the line-of-sight beams can be picked up and bounced along to the next relay station.

MICROWAVE REVOLUTION—The first leg of a proposed nation-wide all-purpose microwave system, linking New York and Boston, is now being completed by the Raytheon Manufacturing Company. Between the two cities six hilltop relay towers are being erected, some 35 miles apart. Microwave beams, like the rays of a searchlight, travel farther from a high elevation, because of the earth's curvature. Ultimately Raytheon hopes to grid the country with microwave networks to serve all the big population centers and many rural areas with new communication facilities.

Further evidence of the coming microwave revolution is Western Union's announcement that the familiar telegraph pole will eventually be banished from the American landscape. The company's ex-

perimental relay network between New York and Philadelphia, using waves about three inches long, can transmit as many as 1280 telegrams simultaneously, and Western Union plans to extend the system over the entire country, making obsolete much of its 2,300,000 miles of wire and underground cable. This project should make possible great savings to the consumer.

Microwaves up to a certain frequency can also be sent through electrical "pipes" under the ground. For several years the American Telephone and Telegraph Company has been working on a system of underground long-distance coaxial cables, through which waves are guided which are much too short to travel along an exposed wire. Through these cables hundreds of simultaneous phone calls, as well as present-day television, FM radio, and other services can be sent. Now A. T. & T. is extending the system to connect the East Coast with Los Angeles, via Atlanta, Dallas, and Phoenix. But the super high frequencies cannot be sent efficiently through coaxial cables and, since these cables are expensive and subject to damage, A. T. & T. is also heading for the hills and is building a microwave relay network between New York and Boston in order to make comparative tests of the two methods of transmission.

Meanwhile, Westinghouse Electric Corporation and the Glenn L. Martin Company have come forward with the most startling project of all. Put television relay stations in high-flying planes, they say, and spray the country with programs picked up by a vertical beam from the ground studio. The best that most microwave broadcasting stations can do is to feed receiving sets



Courtesy Radiation Laboratory, M.I.T.
A laboratory technician struggles with one of the thousands of technical problems which required solution before microwave radar worked well

within a radius of 50 miles. But if a slow-flying plane carrying television and FM transmitting equipment, circles lazily six miles up, it could serve an area of 103,000 square miles. Such a plane over Chicago, for instance, could cover large sections of Michigan, Wisconsin, Iowa, Illinois, Indiana, and Ohio. And if television and FM radio come from the sky, people who live in valleys and near big buildings will not have to worry about shadows or echoes.

All projected microwave systems so far discussed are limited in scope to a single land mass. But how about television across the sea? The International Business Machines Corporation and the General Electric Company, working with the Goodyear Tire and Rubber Company, makers of lighter-than-air craft, may have the answer. The three firms are experimenting with the possibility of placing unmanned dirigibles, controlled by land radar stations, in the stratosphere over the Atlantic to serve as relay stations for microwave fare.

Walter S. Lemmon, I.B.M. executive, predicts that nationwide microwave relays will bring many boons to business. Here's one glimpse. Today, business and professional men by the thousands are making tedious trips to distant cities for conferences which often last no more than an hour. Tomorrow, with television screen in every conference room, groups can confer face to face thousands of miles apart, examine documents, swap stories, and strike bargains. Savings: time, money, sleep.

PULSE TIME MODULATION—Another new method of handling microwaves, called Pulse Time Modulation, will have to be reckoned with. At its first public demonstration, 24 newspaper men entered 24 phone booths and put in calls. Their combined conversations, piped to a "dish" antenna on the roof, were hurled through the air in scrambled form on the same waveband over an 80-mile microwave relay network and back to an adjoining series of phone booths, where other visitors took part in clear intelligible two-way conversations. This amazing performance was made possible by a new tube called the Cyclophon, in which a kind of electronic switch revolves around terminals from each of the 24 phones, dipping into each conversation and snatching a sample 8000 times a second. These bits of sound, electronically numbered and tagged, are sent over the air and unscrambled and arranged in the correct order at the other end. The gaps are much too

brief to be noticed by the human ear.

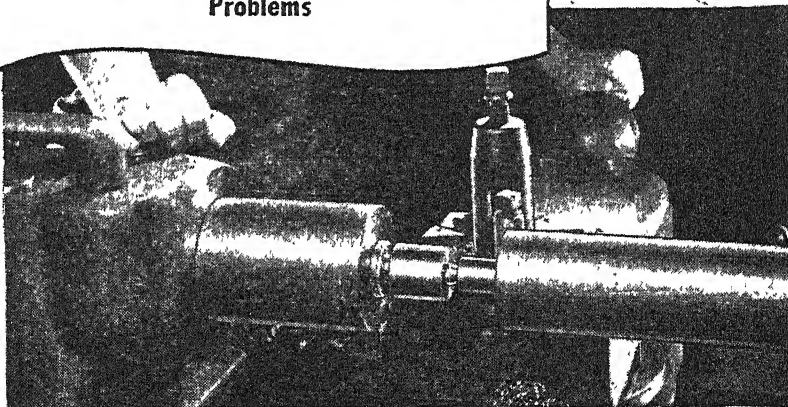
Any number of calls up to 250 can be handled by a system of this type, and with enough relay stations the "package" of conversations can travel 3000 miles as easily as 80. Musical programs require more "samplings" to insure high fidelity, but PTM, as it is called, can transmit a dozen or more programs in the same package. This means that a single station could broadcast all the radio programs in most American cities, with a great saving of equipment. The home receiving set, tuned to a single wavelength, would have a new kind of selector to obtain the various programs. PTM al-

so makes it possible to send television and its sound accompaniment on the same wave band.

STILL "EXPERIMENTAL"—At the insistence of the Federal Communications Commission, all microwave networks now being built are labelled "experimental," but success seems already assured. Data obtained in another year or so may be sufficient to guide the commission in setting rates and allocating spheres of activity. Independent experts, surveying the many microwave projects under way, fear that without a coordinated program there will spring up a helter-skelter pattern of networks, like a dozen

Ingenious New Technical Methods

To Help You with Your Reconversion
Problems



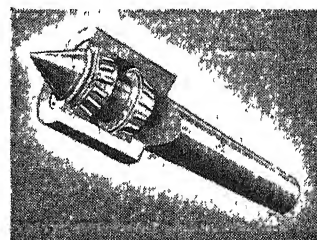
New Precision Built Roto Center Eliminates Chatter...Speeds Production!

Now You Can replace dead centers on lathe and grinder tailstocks, with this new Keene live Roto Center—to increase production—to eliminate all radial play and possibility of chatter! Low in cost, the Roto Center is a high capacity unit, featuring many innovations to speed and improve quality of work!

Matched roller bearings preloaded, are packed with high grade anti-friction grease at assembly. No attention is required for long periods. After assembly, runout is kept to absolute minimum—guaranteed less than .0002. Rear of center is tapped to receive standard hydraulic fitting. Chips, dust and cutting oil cannot reach bearings!

More and more peacetime "helps on the job" are returning to industry. One of these days, famous, flavorful Wrigley's Spearmint Gum will also be back to help you "on the job"—but only when we can assure Wrigley's Spearmint manufacture in *quantity* and *quality* for all. Today, we ask you to remember the famous Wrigley's Spearmint wrapper. Tomorrow, you may again enjoy Wrigley's Spearmint Gum quality and flavor while you are at work.

You can get complete information from
Keene Electrical Machinery Co., 549 W. Washington Blvd.
Chicago 6, Ill.



The Keene Roto Center



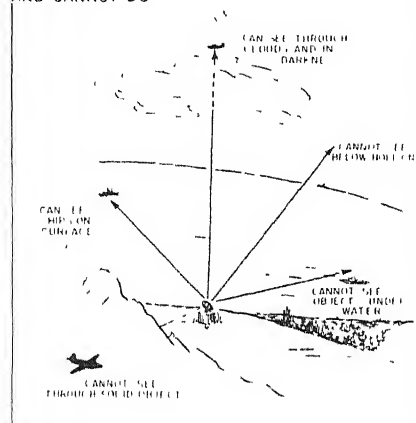
Remember this wrapper

Z-94

railroad lines with tracks of different gages. A standard pattern is imperative as a national defense measure, asserts Dr. M. G. White, Princeton physicist who has been in charge of aircraft radar at Radiation Laboratory.

Another Pearl Harbor might be the last one, warns Dr. White, unless we have a nation-wide radar system connected with microwave relays. Both long-range "early

WHAT RADAR CAN AND CANNOT DO



warning" sets and Ground Control Approach equipment are essential, he says, to spot all planes in the air, regulate traffic, predict storms, and assure safe landings in bad weather, and the microwave network is needed to flash television images of air traffic to a screen in the Pentagon Building in any future emergency. Such a system, he estimates, might cost \$200,000,000 for equipment, and require an operating personnel of 75,000. Since national defense would be only one function of such a system, there are many ways to spread the cost. All the nation's communication — telephone, telegraph, television, radio, facsimile, and whatever else the mind of man can learn to send by radio waves—could be easily handled by such a system, with the various domains parceled out to private corporations.

However the goal is reached, it is inevitable that within a few years the country will be laced with microwave beams, with incalculable effects on our habits and ways of livelihood.



ELECTRONIC VULCANIZER

Speeds Production of Many Rubber Units

FIRST commercial electronic vulcanizer is a mass production unit, a three-story device utilizing 125 kilowatts of electronic energy to service two complete Foamex mattress vul-

canization chambers. It was designed by Firestone and Westinghouse engineers. In preliminary tests, large double-bed mattresses that previously required a 35-minute cure by the old steam jacket method, were completely cured by electronics in five minutes.

As in experimental laboratory tests, close examination of the full double-bed, electronic-cured mattress revealed that the final product was superior structurally to the old type. This is due largely to instantaneous heat supplied uniformly to all parts of the mattress as contrasted to the conventional steam-heated vulcanization of the foamed rubber slowly from the outside of the mattress to the interior. It was also revealed that the steam method cannot always be precisely controlled and that parts of a steam-cured mattress may be completed and other parts of the same product under-cured.

Electronic curing is being applied to the manufacture of other rubber products at Firestone. Large hard rubber wheels requiring five hours of curing by steam may be vulcanized electronically in 18 minutes, brake blocks are cured by electronic energy in 48 minutes that require seven full hours by steam.

FREEDOM OF RESEARCH

Essential to National Progress

DECLARING that "one of the greatest moral injuries Hitler did to the German nation was to suppress the freedom of fundamental research," Dr. Willis R. Whitney, founder of General Electric's Research Laboratory, said in a recent address that "for

fundamental research, which is the most important kind, the scientists need a fifth freedom added to the Atlantic Charter—the freedom of scientific inquiry."

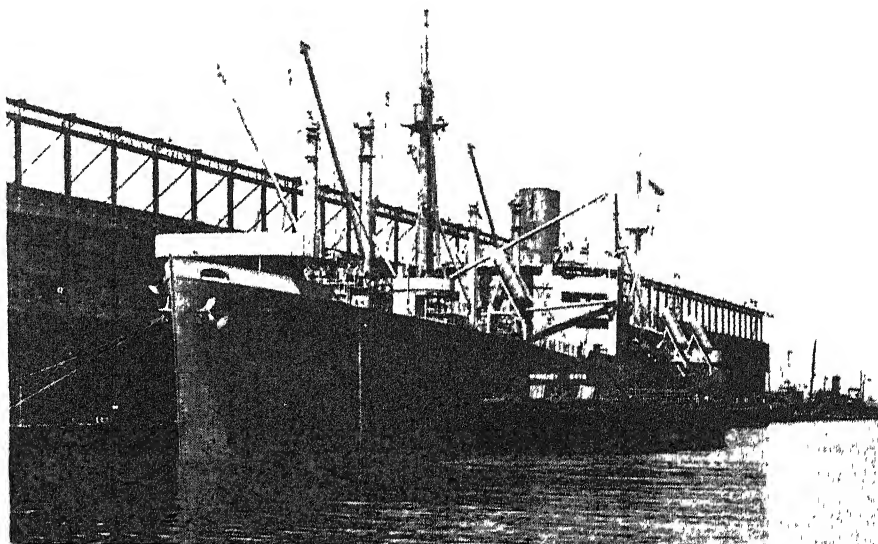
REFRIGERATED SHIPS

Can Carry Any Commodity Requiring Refrigeration

FIRST of five ships of the same design for which the American Export Lines has contracted with the United States Maritime Commission, the *S. S. Excheater* is of approximately 9900 deadweight tons, 473 feet in length overall, and has, in addition to more than 500,000 cubic feet of space for general cargo, approximately 30,000 cubic feet of space for refrigerated cargo. The vessels will be extremely speedy cargo ships, powered to provide a speed of 16½ knots; actual performance has shown that the *Excheater* can exceed this speed. All five are being built by the Bethlehem Steel Company; the refrigeration system is supplied by the Carrier Corporation.

The 30,000 cubic feet of refrigerated cargo space in the *Excheater* is divided into six compartments or "boxes," fitted with the proper insulation to permit the carriage of any commodity needing refrigeration, including all kinds of fresh fruits and fresh meats, having a controlled temperature ranging from 60 degrees, Fahrenheit, down to zero, Fahrenheit.

Refrigeration is provided by means of air cooling, which is supplied by six Carrier F10on-12 compressors, with one spare compressor as a standby. The system is so arranged that each compressor can be used on any cargo box.



United States Army Signal Corps photo of the refrigerated *S. S. Excheater*

Although these refrigerated cargo vessels were designed to be operated in military service of the government, they are built to meet the future requirements of American Export Lines in the company's trade routes to the Mediterranean, the Black Sea, and India

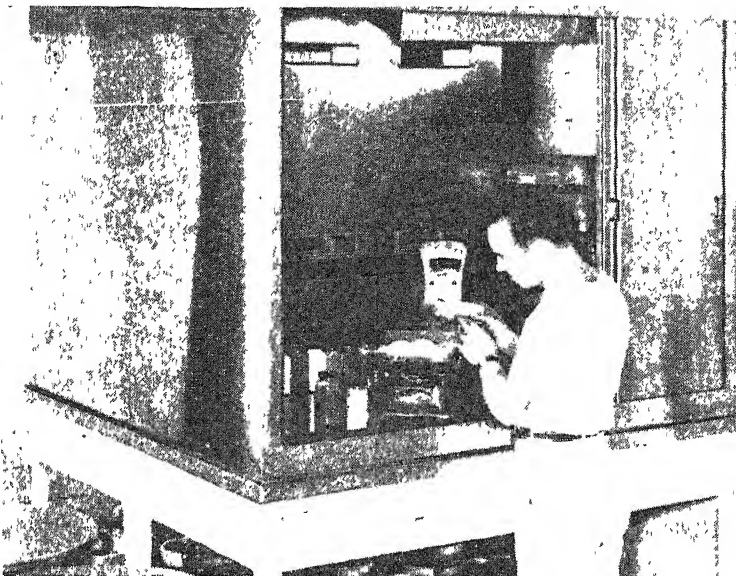
PATTERNS

*Eliminate Need for
Elaborate Measurements*

A NEW patterning process speeded aircraft and ship production and is expected to apply to many industries in the future. Template reproduction, the newest method of getting information from designer to machinist, may replace scale drawings and blueprints or other reproductions in which dimensions are indicated by figures. It is, in effect, a return to lofting practice used in ship building, where a full-size duplicate of the part to be made is used as a pattern.

With conventional methods there are four steps, each subject to human error, especially in reading dimensions: the engineer's rough design, the detailed layout, drawn to scale and dimensioned; the blueprint; and the full-scale layout made in the factory. With template reproduction the design engineer draws a full-scale pattern on a metal sheet coated with dull white lacquer. Details, including rivet holes, are shown, but only basic dimensions, such as the relation of wing to body in an airplane, are indicated by figures. From this point on, reproductions, all full-scale, are made by mechanical means.

Several methods are used to reproduce the original design on metal sheets which may be cut to form shop templates. In one common method, a glass plate coated with a photographic emulsion is placed against the design and a light is shone through it. After development, the design appears in white lines on a black background. The plate is then placed against a fresh metal sheet coated with the white lacquer and with photographic emulsion. This combination, exposed as in making an ordinary photographic contact print, reproduces the design in black on white on the metal sheet. In a similar method, phosphorescent lacquer pigments on the original design provide the light source, and the negative is a metal sheet. Another method uses two rooms as a camera, a lens in the partition focuses the design on a photosensitive metal sheet, which becomes the negative. Non-photographic methods, including offset lithography whereby an inked design is transferred to a rub-



EXACT WEIGHT Scale weighing color pigments in an enclosed stainless steel laboratory hood. Electro Metallurgical Company, New York

Colors in the Middle Ages and Now . . .

The colors of the middle ages were beautiful and lasting yet they lacked uniformity. The reason? They were solely the product of individual skill. Color compounding today is strictly a mechanical operation . . . weighing to the fraction-ounce. Color success now is the right equipment for the task. Failure to attain perfect color matching today is almost entirely due to equipment. There are several EXACT WEIGHT Scales for color compounding. Fine jobs require delicate weights to 1/1000 oz. . . mass color jobs not so fine. This is but another operation in modern American Industry handled by these famous scales. What is your problem? Write us!

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Exact Weight Scales
THE EXACT WEIGHT SCALE COMPANY

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ber roller and thence to the duplicate metal sheet, are also used.

The metal templates go directly to the factory to be used as models. Jigs are also made directly from such templates without additional layout. One or more of these methods should be especially useful in the future to those industries engaged in manufacturing frequent new models from raw materials in sheet form.

The principal advantage of template reproduction is the reduction of human error after the original design is made. It has been estimated that templates can cut tooling time 60 percent. Assembly time can be

reduced by making sub-assemblies of the templates to be used as models. Template reproduction costs little, and the entire process takes less than a half-hour. By comparing the finished part with the original template, the final inspector has a visual check and need not make elaborate measurements. Metal templates can also be sent to subcontractors.

Template reproduction is now being used in many phases of aircraft and ship manufacture, from engines to plastics turrets, and is expected to apply to automotive industries in the future. It has simplified the design

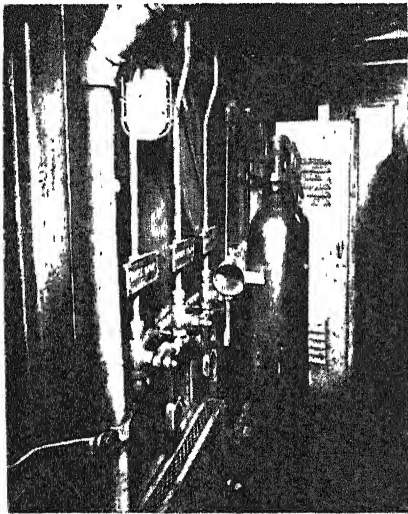
of new models of refrigerators and has been used or proposed for many other products and purposes from plastics lamps and candlesticks to home boat building.—*Industrial Bulletin* of Arthur D. Little, Inc

EXTINGUISHERS-ON-RAILS

Safe-Guard Streamliners Against Fires

FIRES on Diesel-electric locomotives, that might be whipped to dangerous proportions in the winds caused by "streamliner" speeds, can be promptly detected and extinguished by new equipment installed on the engines that pull such famous Florida trains as the Silver Meteor, Sun Queen, and Palm Land for the Seaboard Air Line Railway. The equipment was developed by the C-O-Two Fire Equipment Company and the Pyrene Manufacturing Company.

The system turns a regular Diesel-electric locomotive into a veritable



Built-in carbon dioxide fire extinguishing equipment on a locomotive

"fire-engine-on-rails," since the apparatus automatically detects both smoldering and fast-burning fires underneath or inside the locomotive, and can kill fires inside the cab while traveling at high speeds or, when the train is stopped, extinguish flames under the train or along the right of way.

Fires over the engines are detected by a thermostatic system which turns on a red "fire alarm" light and sounds a gong. Electronic smoke-detecting apparatus, which it is claimed will function even while the train is traveling 100 miles an hour, reveals fires in the battery boxes or on the under side of the locomotive. Fires at these points result from accumulations of road dust, dry grass, and paper that becomes saturated with oil, and are set aflame by sparks from the brake shoes, and, since the flames are not visible to

the crew, considerable damage may result unless some means of fire detection is provided.

In the engine compartment, fire is extinguished by means of a built-in carbon dioxide system which floods the endangered area with a dry, inert gas, which is a non-conductor of electricity and quickly smothers fire. For fires inside or underneath the engine, a carbon dioxide hose reel, hand extinguishers, and foam playpipes are provided. By a simple control, the playpipes may be used to discharge either high expansion mechanical foam for oil and gasoline fires or plain water for wood and brush fires. Oil or brush fires as far as 100 feet from the train along the right of way can be extinguished by means of the playpipes.

ENGINE STARTER

Uses Cartridge to Rotate Crankshaft

STARTING of aircraft engines has long been a source of trouble, especially with modern high-powered engines. Hence the development of the cartridge engine starter, manufactured by Breeze Corporations, Inc., under Coffman patents, has proved valuable to aviation in general. It is possible that this new engine starter will find further use on aircraft which use airports where battery-cart facilities are lacking.

The theory behind this simple engine-starting device is to use the energy of a fuel contained in a cartridge, placed in a specially designed breech mounted in the cockpit or under the cowl, to provide torque to turn the engine over at a speed sufficient for starting.

Its advantages are: (1) ample power, yet minimum torsional shock to the engine parts; (2) the pilot can start the engine quickly without the aid of ground mechanics; (3) no drain on storage batteries, thus en-

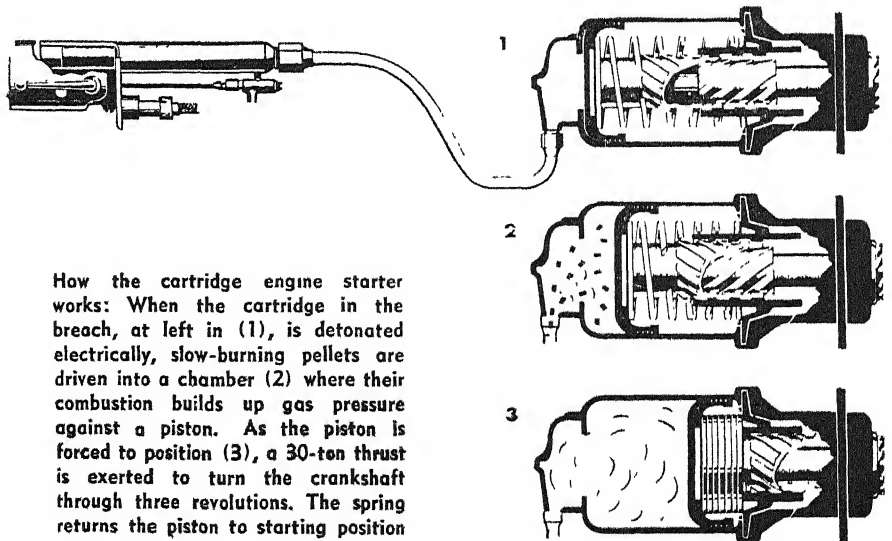
abling light-weight batteries to be used, which increases pay load; (4) since far less priming is required to start, engine life is increased. In operation, the cartridge is placed in the breech; then when electrical contact is made it ignites a quick-burning powder which in turn drives slow-burning pellets into the combustion chamber of the starter. As combustion proceeds it builds up gas pressure against the starter piston. The power stroke begins when the helical splines impart a rotary movement to the clutch jaws. The engine has made three revolutions by the time the power stroke of the starter is completed; a valve then opens and a helical spring returns the starter piston to its original position. A 30-ton thrust is converted to 180 revolutions per minute of the crankshaft.

It is readily apparent that this mechanism is subjected to high stress and shock in its main working parts, and hence must be built of strong and tough alloy steels. Since corrosion-resistance also is a consideration, stainless steel is specified for the cylinder forging, and for parts of the breech mechanism (which are forged and heat treated), for the tubing which connects the breech with the combustion cylinder, and for the more important gears and shafts which are heat treated to a Rockwell C hardness of 38/42.—*Nickel-Steel Topics*.

MILLED GLASS FIBERS

Improve Paper, Plastics, Abrasives, and Paint

RESearch now being conducted in the laboratories of Owens-Corning Fiberglas Corporation and in the laboratories of other manufacturers points to numerous uses of a new material—Fiberglas milled fibers—as a reinforcing agent for special papers, plastics, and abrasive com-



How the cartridge engine starter works: When the cartridge in the breech, at left in (1), is detonated electrically, slow-burning pellets are driven into a chamber (2) where their combustion builds up gas pressure against a piston. As the piston is forced to position (3), a 30-ton thrust is exerted to turn the crankshaft through three revolutions. The spring returns the piston to starting position.

pounds. The milled fibers have also been employed successfully to improve the special characteristics of sound-deadening paints

Fiberglass milled fibers are formed by hammermilling Fiberglass continuous yarns into maximum lengths ranging from one thirty-second of an inch to one and one-half inches. Diameter of the fibers, in all lengths, is 25 one-hundred-thousandths (0.00025) of an inch. Appearance of the fibers varies with the maximum fiber length. The shortest lengths are tightly nodulated, while the longest sizes form a loose mass.

The tear strength of explosive paper, used for wrapping dynamite, is materially increased by the addition of 10 percent, by weight, of three-quarter-inch milled fibers. The presence of the glass fibers provides a better bond between the paper and the paraffin used to coat it. Hinging action is minimized. Because dispersion of the glass fibers in the paper gives it more uniform strength, the paper disintegrates after the explosion, instead of leaving small pieces to smolder and perhaps to cause a fire.

Ten percent, by weight, of the milled fibers dispersed in filtering paper gives it more uniform capillarity and speeds the filtering process. The fibers act as veins which conduct moisture rapidly throughout the paper. Because of this characteristic, the same percentage of the fibers in laminating paper speeds impregnation by the resin and reduces curing time.

These milled fibers have been successfully incorporated in high-pressure resins (melamine) to form molded plastics switch boxes. Tests show that the product has increased impact strength, an arc resistance of 183 to 186 seconds of flash in contrast to from two to five seconds of flash when other fillers are used, and that when burned (A.S.T.M. test) there is a weight loss of only 3 percent as compared to the 30 percent weight loss when other fillers are incorporated in the resin. These improved characteristics indicate that the milled fibers are adaptable to many other applications in the high-pressure molded plastics field.

A 300 to 400 percent improvement in impact strength and generally longer life have been given phonograph records by replacing organic filler material with 3 percent, by weight, of the one-eighth-inch Fiberglass milled fibers. Record deterioration is frequently due to the presence of microscopic blisters in the sound track. Such blisters are attributable to swelling of organic filler material, caused by moisture absorption. Since the milled Fiber-

glas fibers are microscopically fine solid glass rods they can neither absorb moisture nor swell. No increase in the noise level is caused by the presence of the glass fibers.

Strength and performance of abrasive cutting wheels have been improved by incorporation of one-quarter-inch Fiberglass milled fibers in the abrasive grain (chopped silica, carborundum, and so on) which is mixed with a thermo-setting binder and molded into form. Addition of the milled fibers has increased by 25 percent the strength of 12-inch-diameter, one eighth-inch-thick wheels used to cut the bead off molded metal products. Top operat-

ing speed has been increased from 15,000 to 17,000 revolutions per minute. The heat generated is dissipated rapidly and less tendency to burn the metal is shown.

Fiberglass milled fibers ranging from one-sixteenth to one-thirty-second of an inch in length have been incorporated in sound-deadening paints, with a resulting improvement of 100 percent in sound deadening qualities. The paints, sprayed on metal surfaces, "de-ping" the metal by reducing the vibration. Their chief field of use is the automotive industry where they are applied to the interior metal surfaces of passenger cars and trucks.

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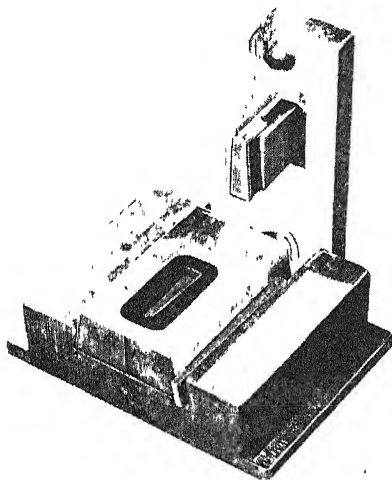
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New Products and Processes

DIE INSERTS

*Of Sintered Carbide
Have Long Life*

BLANKING and forming dies that multiply by 10 to 1000 the number of pieces produced per grind, that save—in down time—from six to eight weeks' production per year, and that are ex-



Long-life Diecarb punching die

pected to lower production costs on thousands of commodities, are now available to industry. Using inserts of Diecarb, sintered carbide combinations with a Rockwell hardness of from 65 to 73, tests have been underway in a diversified group of industrial plants for some time.

The life of a Diecarb die has not yet been determined for the reason that each such die manufactured is still in use or in operating condition. The "breakdown" point, where regrinding becomes necessary, of blanking dies with sintered carbide inserts comes only after extremely long usage.

The Firth-Sterling Steel Company manufactures the Diecarb in four grades. In addition, the company is embarking on plans for an educational program to provide engineering assistance on the application of sintered carbides to die-making.

VAPOR TRAP

*Salvages Cutting
Oils or Coolants*

COLLECTING vapor from oil or cutting fluids arising from cutting, grinding, and similar operations and returning it to the source of its supply is the job done by a new Dustkop recently announced by Agat-Detroit Company.

The new vapor collector is for use on

virtually any type of high-speed production machine tools employing cutting oils or coolants. It employs a motor-driven multiple blade fan to provide suction to draw the vapor from the vicinity of the operator and the work. The vapor laden air is sent against the inside surface of spun glass filter material where the vapor condenses and is collected in a pan, the cleaned air being recirculated into the working space. This collected fluid is returned to the sump or reservoir of the machine tool through the faucet provided on the pan.

Installation is made with either ordinary sheet metal pipe or flexible metal hose of five-inch diameter which fits the inlet flange of the collector and can be located near the source of the vapor.

ELECTRICAL MICROMETER

*Uses Frequency Modulation
Principles for Extreme Precision*

HAVING a precision never yet required by industry, an unusual type of electrical micrometer measures movements, or changes in position, as small as one-tenth of a millionth of an inch. It can measure rapid changes in position only one thousandth as large as the thickness of the printing ink on a newspaper, or about one fifty-thousandth the thickness of newsprint. It is so sensitive it can record changes much smaller than the wavelength of light, which is the standard used in calibrating it.

This new tool of science utilizes the principle of frequency modulation (FM) radio to measure the position of either slowly or rapidly moving objects without touching the object being

measured. It was developed by Battelle Memorial Institute technologists as a research tool and has already been utilized in several important war investigations.

The first application of the new device at Battelle was to measure the errors in high precision lathe spindles used in machining aircraft motor parts. With it minute errors could be determined, and spindles designed on the basis of information given by the instrument have extreme precision.

The instrument is also the heart of an apparatus used for measuring and recording the changes in crystal structure when steel is heated rapidly, as in electric welding. This apparatus provides valuable help in assuring good service from welded structures, such as ships, bridges, and heavy industrial products.

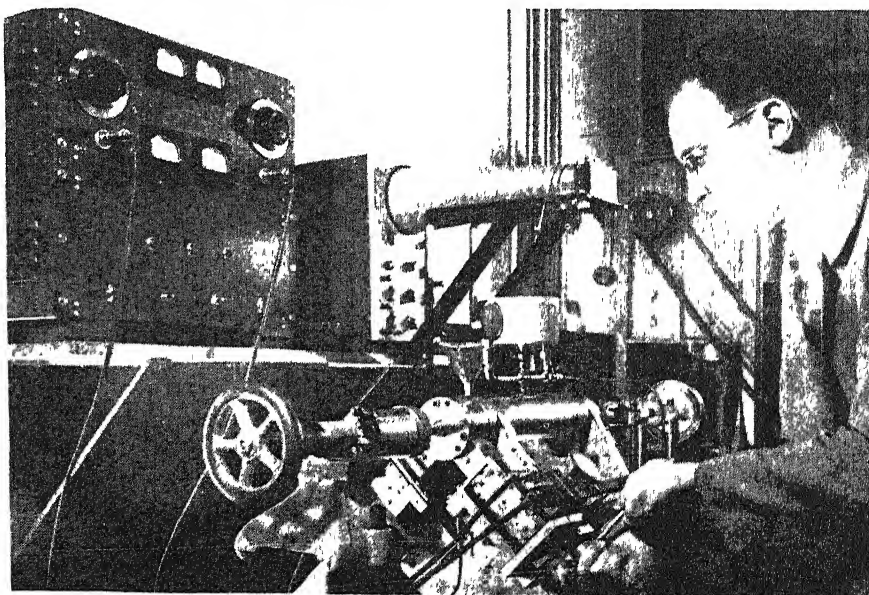
CENTRIFUGAL CASTING

*Produces Parts of
Virtually Pure Copper*

COPPER parts for certain electrical apparatus can be cast centrifugally, obtaining a consistently better quality than would be possible with sand casting and reducing the amount of scrap per casting. Possibility of the occurrence of sand holes and blow holes inherent in the sand casting method is eliminated, and the centrifugal method provides a much denser metal.

As this method is applied at General Electric, the copper is brought up to a temperature of between 1200 and 1250 degrees, Centigrade, or 100 degrees higher than the temperature required for sand casting. Meanwhile, the runner box and die are heated with torches to a temperature of approximately 250 degrees, Centigrade.

After the drosses are skimmed from the surface, the molten copper is poured into the runner box, from which it flows into the spinning die. When more than one crucible is used, the opening between the runner box and die is plugged long enough to prevent any interruption between the charges, thus



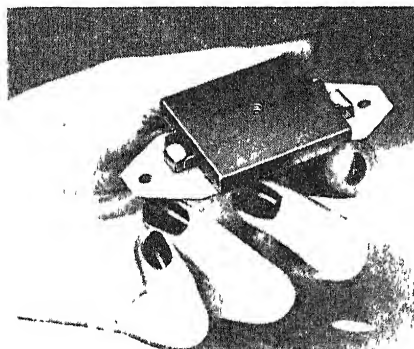
Lathe-spindle precision is measured with the electrical micrometer

avoiding the possibility of a cold shot. The die is kept spinning at about 300 revolutions per minute for two minutes. After the casting is removed, impurities remaining at the inside of the ring are removed by machining. The final result is a ring of virtually pure copper.

VIBRATION REDUCED

By Simple Mount That
Handles Small Loads

A NEW light-duty mount which will handle loads as low as one pound, eliminates disturbing vibration and noise from small motors, typewriters, business machines, household appliances, and small power tools. It will also isolate delicate instruments, tables, desks, from external vibration. Known as Rexon Mounts and made by Hamil-



High vibration dampening properties

ton Kent Manufacturing Company, the mount design, a departure from conventional practice, combines the high vibration dampening properties of rubber loaded-in-shear, with the safety, durability, and ease of installation of a simple compression mount. With the average shear mount, loads must be carefully calculated as any overload may seriously damage the mount. With Rexon mounts it is reported that no overloading of the shear elements is possible.

UNIVERSAL ADHESIVE

Stems from a Family
Of Synthetic Rubbers

DEVELOPED to meet a host of needs wherein an unusually strong and all-purpose adhesive is required, Pliobond, a "universal adhesive," can be applied either as a cold setting cement or under heat and pressure, depending on requirements.

Born in the Goodyear Research Laboratory, Pliobond is an entirely synthetic complex compound with resin-like properties, but also with rubber-like characteristics. It stems from a family of new elastomers, more commonly called synthetic rubbers, and has an amazing affinity for a very wide range of substances.

The new adhesive has already been successfully employed for bonding a variety of materials including metals, plastics, fabrics, ceramic ware, vulcanized rubber, paper, leather, glass, plaster, wood, and Portland cement concrete. It has also proved feasible

The Editors Recommend

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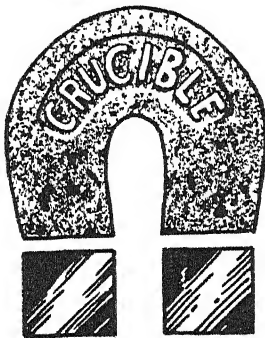
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to bond, by use of Pliobond, any of these materials to each other. In many cases where Pliobond is used, the bond itself is stronger than the bonded materials, and it has the added advantages of being flexible, water-proof, and resistant to the actions of chemicals, hydrocarbons, and oils or greases.

Shock-resistant and shock-absorbing assemblies have become of increasing importance. Most of our means of transportation involve vibration, which is hard on adhesives and hard on delicate instruments as well as on human beings. Pliobond is reported to be outstanding in shock-resistance, and makes possible rapid assembly of shock-absorbing mountings.

In electronic equipment, there are many places where insulations must be bonded to metal. Pliobond has shown promise of solving some annoying problems in this field.

It produces bonds between fabrics stronger than the fabric itself and, because it is resistant to many chemicals, has shown promise in the assembly of work clothes, handbags, luggage, and other articles wherein fabrics and more rigid material are brought together.

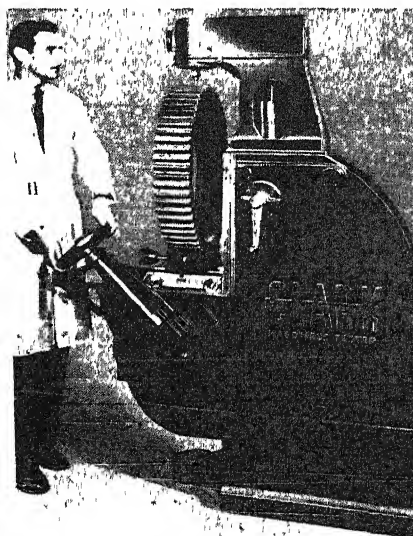
Pliobond bonds metal to metal. It can be used to assemble quickly and accurately jigs and fixtures, because the bonding is simple, the heat is insufficient to cause warping of the metal, and, if necessary, the bond may be disassembled by suitable means that will not harm the assembly. In delicate equipment where riveting, soldering, or welding may be impossible or difficult, Pliobond should serve.

It is obvious that Pliobond can also be an outstanding repair material in shop and home, since it can be used to mend all sorts of flexible and rigid articles and combinations.

HARDNESS TESTER

Adaptable to Large
or Small Pieces

GIVING a true "Rockwell" reading, with either a diamond or steel ball penetrator, a new hardness tester can handle parts ranging from 1/2 inch to 26



Testing hardness of a large gear

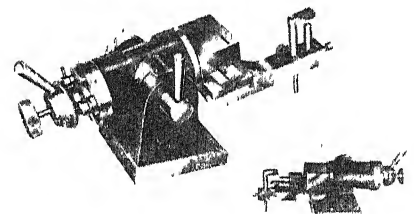
inches. The adjustable height table is supplemented by a movable capstan easily varied to match the table height. A roller bearing carriage on the table facilitates positioning of heavy parts.

Operating technique and readings for this Clark Hardness Tester are similar to the familiar "Rockwell" tester.

WHEEL DRESSER

Operates to
Close Tolerances

AN ANGLE correcting radius dresser that provides complete wheel dressing service in which the operator can dress a radius, an angle, a compound-complex angle, and an angle tangent to a radius, in one operation is announced by the U. S. Tool and Manufacturing



Primary position of radius dresser, with secondary position for large or small radii shown at lower right

Company. When these four operations are performed the primary diamond holder position is used but provision has also been made for forming extremely small or large radii. For this work, an accessory is used which consists of a special diamond holder mounted in a secondary position.

To make it practical to dress an angle tangent to a radius and the radius too, in one continuous operation, the dressing arm is provided with a calibrated rack adjustment. This makes the matching of radius and tangent a routine matter, with the diamond in either primary or secondary positions. If these jobs are done as separate operations on single-purpose radius dressers, the most expert handling is required. In this one device, together with the one diamond holder accessory, is embodied all of the equipment that is required for any kind of wheel dressing, and close tolerances may be maintained throughout.

ENGINE HOSE

Resists High Pressures
And Temperatures

ENGINES of airplanes will be lubricated and cooled more efficiently as the result of the development of a new synthetic rubber hose which offers increased resistance to heat and pressure. Perfected by engineers of the United States Rubber Company, the improved hose is designed to withstand temperatures up to 250 degrees, Fahrenheit, for use in oil lines and up to 300 degrees for installation in cooling systems.

Resistance to pressure in hose one inch in diameter is double that of hose formerly used. The strength is increased proportionately in the other

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sizes, ranging from one-quarter inch to two and one-half inches in diameter.

One of the principal features of construction is a new high-strength carcass built with Ustex, a chemically-treated cotton yarn which is much stronger than regular untreated cotton yarn. Special heat-resistant synthetic rubber was perfected after extensive research and experimentation in the United States Rubber Company's laboratories.

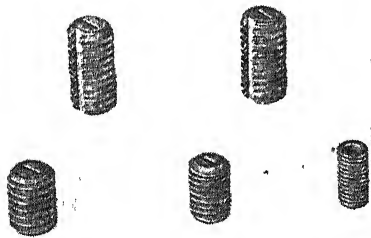
THREADED CORES

Contribute to Compactness
Of Radio Receivers

SCREW type molded iron cores for radio transformers, now being made generally available, offer many engineering and constructional advantages by virtue of the fact that the cores themselves are threaded. No brass core screw is necessary for adjustment.

Smaller assemblies are readily possible because the overall length of a coil and screw type core is less than that of the conventional core, machine screw, and bushing. Thus smaller cans can be used and threaded coil forms are unnecessary in many cases. Instead, "C" clips extending through slots in the coil forms can be used to contact the core threads.

The design of i-f and dual i-f transformers for AM and FM is greatly facilitated by screw cores since such



Screw type cores for radio coils

units may be tuned from one end of the transformer-can simply by placing the coils side by side. Antenna, r-f, and oscillator coils for each band of multi-band sets become small and compact by use of these screw cores, made by Stackpole Carbon Company, and may be mounted in groups for each band

SPONGE RUBBER

Assists Workers in
Picking Up Parts

EMployees in a large industrial plant were having difficulty picking up small metal parts used in the assembly of one product. The assembly line traveled past them faster than they could pick up the parts—but not faster than they could work. The chief trouble was that the workers fumbled the small parts and couldn't get them off the table at the speed necessary to keep up with the production line.

An engineer of The B. F. Goodrich Company suggested that the table be covered with a thin slab of sponge rub-

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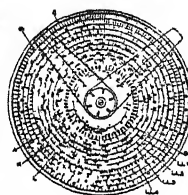


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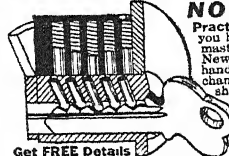


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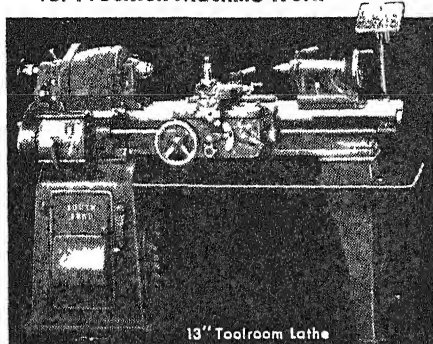
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ber, so the workers could get the tips of their fingers easily around the small parts and place them in the assembly. It worked from the start, and the assembly went off the line on schedule.

The sponge rubber slab can be as thin as ⅛ inch and still enable workers to get their fingers into it to pick up the parts, although different sponge thicknesses and densities may be required for some jobs.

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For Chemical Cleaning
of Small Parts

A METAL dip rack has been developed to fit a standard five-gallon container, thus providing a simple means for cleaning small parts by immersion in a self-sealing compound known as Fuzee. According to its manufacturer, Turco Products, Inc., the compound quickly and thoroughly removes stubborn carbon, engine varnish, and other adhesive dirt from pistons, fuel-pumps, and carburetors.

Most effective solvents for removal of dirt have been dangerous to use, being high in volatility, inflammability,



Rack fits a standard container

and obnoxious fumes. These solvents are also rendered rapidly useless by corrosive contamination. Turco chemists have overcome these difficulties and dangers in Fuzee by use of a compound on the surface of which a "seal" floats. This seal practically eliminates fumes, and other troubles.

FOUNDRY OVEN

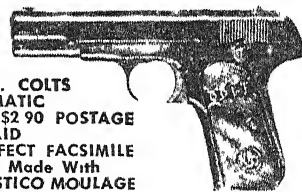
Bakes Cores Rapidly
Yet Uniformly

GAS FIRED, a two-section batch type oven, using forced convection and recirculation, has completely eliminated rejects due to faulty baking and has saved considerable floor space in a mid-west foundry. Replacing two older ovens, located in different parts of the foundry, the new Despatch oven consolidates core baking operations and provides ample capacity for present and future production requirements.

A new type of duct with adjustable scoop ports provides uniformity of heating. The C. W. Olson Manufacturing Company reports that since the new Despatch oven has been in operation—about two months—they are baking flywheel cores with perfect uniformity in two hours that previously required three hours to bake (and then some were green and some burned). This represents a saving of 33 percent in

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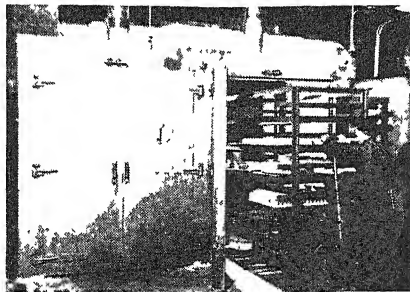
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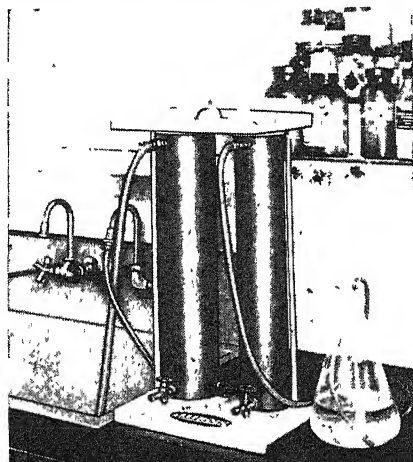
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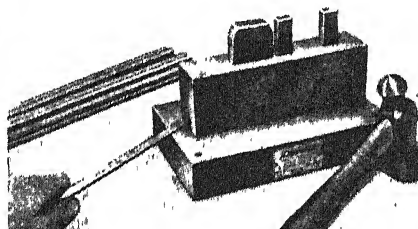
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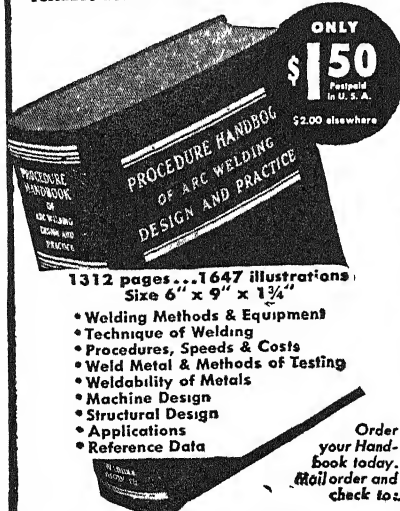
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(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below)

PLASTICS PRIMER, an eight-page booklet about phenolic plastics—the most versatile of all plastics, is especially designed to help clear up any existing doubt and confusion as to what plastics are, the different types, their properties, and applications. *Durez Plastics and Chemicals, Inc., North Tonawanda, New York.—Gratis.*

INDUSTRIAL SAFETY TOMORROW—a pamphlet prepared by 38 co-operating organizations comprised of business, labor, government, and educational leaders—outlines a program for prevention of industrial accidents, techniques which can be used, and the need for coordination of all groups concerned with safety. *National Safety Council, 20 North Wacker Drive, Chicago 6, Illinois.—Gratis.*

BORING CHUCK is a six-page folder describing a new boring chuck which can center drill a hole, bore a hole, and then drill again without removing the boring chuck. Specifications are included as well as information on how to use this tool as an adaptor for special tools like end mills, cutters, keyway cutters, saws, and fly tools. *De Soto Tool Company, 16 Sproat, Detroit 1, Michigan.—Gratis.*

ENGINEERING-DESIGN DEVELOPMENT OF X-RAY SPECTROMETER by J. S. Buhler, is a 12-page booklet covering the basic design principles of the Geiger-Counter X-Ray Spectrometer, a recently developed industrial control tool. *North American Philips Company, Inc., Publicity Department, 100 East 42nd Street, New York 17, New York.—Gratis.*

THE ROMANCE OF THE SMITHSONIAN INSTITUTION is a 32-page booklet describing a set of books which, through leisurely reading, will bring to you all the knowledge and culture of The Smithsonian Institution. *The Series Publishers, Inc., Department SA, 11 West 42nd Street, New York 18, New York.—Gratis.*

MACHINES, PRICES, JOBS, a 12-page booklet, discusses the historical relation between jobs, machines, and prices and tells how improved machinery contributes to a high employment level at good wages. *National Machine Tool Builders' Association, Cleveland, Ohio.—Gratis.*

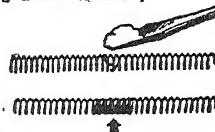
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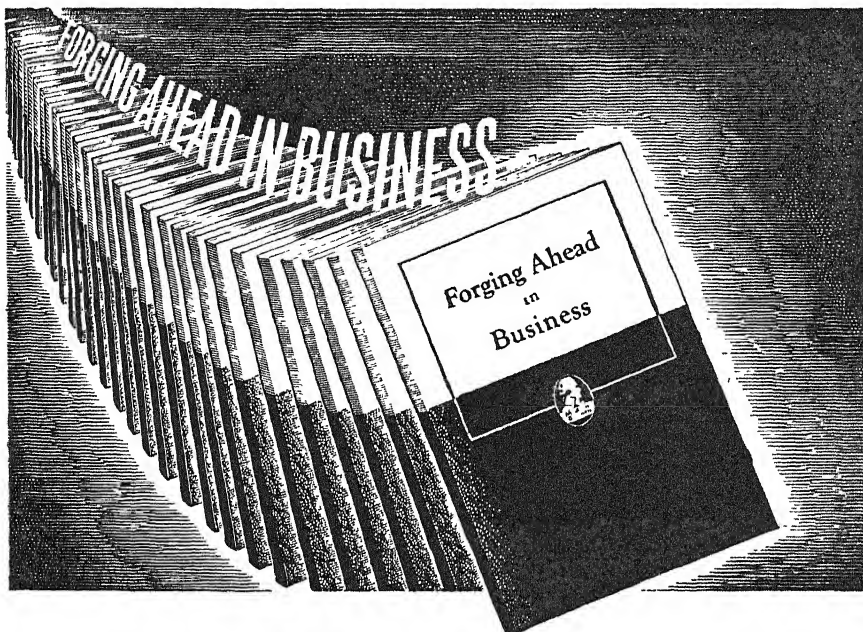
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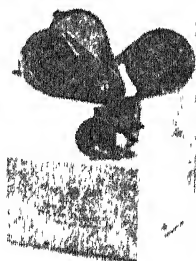
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Telescopes

A Monthly Department for the Amateur Telescope Maker

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Editor of the Scientific American books "Amateur Telescope Making"
and "Amateur Telescope Making—Advanced"

LAST month in this department Dr Henry Paul, Norwich, N. Y., described the grinding half of his combination grinding and polishing machine for making telescope mirrors, optical flats, and lenses. The polishing part was shown in Figure 2 (in the previous installment) and is shown from another angle in Figure 3. Because it is believed that numerous amateurs will find in this machine one particularly outstanding advantage which they may wish to embody in similar machines, enough space will be devoted to it to afford adequate description.

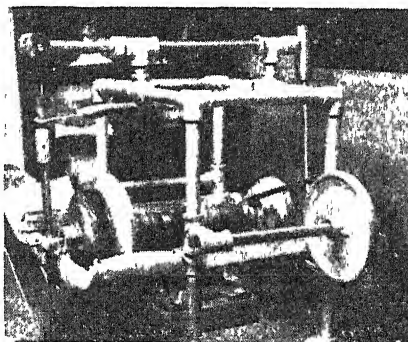
The action of the polishing part of the Paul machine may best be traced by starting at the motor, under the table, which actuates the grinding part described last month. From a 2" pulley (the remainder of the cone pulley seen in Figure 2 never being used) a V-belt passes up through a slot in the table and drives a 5" pulley which is eclipsed in the illustration. This pulley is attached to a short horizontal shaft, in this instance an old grinding head. On the left-hand end of this shaft (in Figure 3) is a head plate to which the mirror is attached with pitch. The mirror rotates constantly in a bath of rouge water and therefore requires almost no attention. This in turn requires that it be turned in an uncommon position—in a vertical instead of the familiar horizontal plane. Speeds of 70, 105, 140, and 175 r.p.m. may be chosen by selecting suitable motor pulleys.

Suspended on an upright pin bar is the lap, which is held against the mirror by means of a spring or large strip of inner tube stretched to the desired tension as measured by a spring scale. The pin bar is actuated, pendulumwise, by the horizontal overhead shaft, and this in turn is kept rocking by a belt-driven jack shaft and crank arm, through an articulated pitman and pitman bar which is hidden in Figure 3 but visible in Figure 2.

Stroke length may be varied by moving the crank pin along the crank arm. Stroke position is altered at will by readjusting a clamp at the top of the pitman. Unorthodox as it at first appears to be, this machine includes all the necessary elements and motions of an orthodox machine and, in fact, it is an orthodox machine turned up on its side in an unorthodox manner in order to make possible the added advantage of the rouge bath. If, for illustration, you take the commercial machine shown on page 83 of the 1944 printing of "A.T.M.A." (Ferson's new chapter on prism and flat making) and tip it over on its side like a kicked-over table, you then have about the same

principle. On the Paul machine, however, polishing is accomplished somewhat more by rotation than by cross stroke.

THE HORIZONTAL polishing system was first seen in the shop of Dr. Henry Ketcham, Johnson City, N. Y.," Paul states. "It offers certain distinct advantages, the major one being that, after initial adjustments on the job, it requires little attention, being semi-automatic. Since the lower edge of the mirror and of the lap dip as much as half way to their centers in the trough (old inner tube) of rouge water, the bother of applying rouge to the lap by hand is eliminated. It is true, the rouge water splashes all over the mirror and tool but a large washer



Photograph by Dr. Henry Paul
Figure 3: Paul's polishing machine

on the drive shaft, running just inside the trough, keeps most of it where it belongs. Another eliminated factor is temperature gradients due to evaporation effects.

"Turned edges of any consequence have not been encountered (when the system was properly used). An added advantage is the fact that in the earlier stages of polishing, the trough that holds the solution may be moved up close to the mirror, thus keeping all the rouge in operation for rapid polishing. Then, as the end of the polishing is approached, the trough may be lowered, permitting the coarser particles to settle to the bottom so that the later stages of polishing may be accomplished by finely suspended rouge. It is believed that one reason for the outstanding lack of scratches by this method is the fact that heavy particles tend to stay in the bottom. This may also be why ordinary optician's dry rouge (B. and L. 21-90-61) works well. Since much of it is used, five-pound containers are obtained, but at relatively low cost.

"The polishing progresses somewhat slower than by conventional methods, but this is compensated in advance by thorough fine grinding with very fine

emery, such as American Optical No 305, the last application being worked down extremely well. Finest emeries should be levigated and mixed, one-to-one, with levigated drugstore talc. I have never had a scratch from this method of polishing.

"I have often started a mirror polishing in the late evening and leisurely after breakfast stepped down to the shop to find a completely polished surface within a few wavelengths of the ultimate. Thus I call this the night-shift machine; it works while I sleep (Once I let it run 24 hours. No harm resulted.) To avoid the heartache, only too well known to all mirror makers, of fortuitously reaching a perfect curve before polishing is complete, and then helplessly having to watch its demise, I prefer to do the figuring on a finished polish. A small condenser-bulb pen light and a 7× to 10× magnifier is used to best check for complete polish.

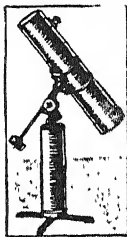
"The free-running lap or mirror under the swinging arm pin is usually made about 5/6 to 9/10 the diameter of the driving lap or mirror on the polishing spindle head. Most often the convex form, whether lap or mirror, is on the driving spindle head and the concave form turns free on its supporting pin. Flats have been made both ways—most often, however, with the flat on the polishing head and the smaller polisher free-turning. The center of the free-turning disk is usually kept somewhat above or below the center of the polishing head. Often the edge of the free-turning lap comes within 1/8" of the edge of the disk it is polishing. This tends to avoid turned edge. Laps need only simple channeling—one groove across and three equally spaced channels at right angles to this.

"Between adjustment of the length of the stroke, the position of the sweep across the disk of the polishing head, the size of the outer versus the inner disk, the distance the center of the rotating disk is held above or below the center of the polishing head disk, and the reversal of position of the lap and glass, almost any desired effect in spherical or flat surfaces can be produced.

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"Often, in figuring on the vertical spindle, the small polishers are held in the hand and applied to the spinning glass, using a ruler held in the left hand to gauge the place of application. When using the finger alone as a polisher on a narrow zone this must

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Harvard Observatory, Cambridge 38, Mass.

be done more cautiously, as operation may be rapid. When the pin is used in the back of the lap, effects will vary according to whether the lap is free-spinning, partially braked by the left hand, or totally stopped from rotating. See Dève, 'Optical Workshop Principles,' pages 70-72.

"The 'trapeze,' or pipe frame, set up to support the moving mechanism of the polishing assembly has worked extremely well. It is constructed of ordinary 1/2" pipe fittings, the list being 12 6" lengths, four 3-way connectors, ten T's, and four flanges. The respective sides can be constructed as units. Here arises the interesting and slightly humorous problem, sometimes handed to unsuspecting apprentice plumbers, of 'closing a circle' with pipe fittings. The apprentice discovers that screwing one end of the fourth side into one elbow automatically screws the opposite end out of the other elbow. One solution is to screw the left end in extra far, cut off all but two threads from the right end and then turn that end in, completing the square. This will leave the left end a bit loose but a setscrew will tighten it. My less elegant solution was to turn a blowtorch on it and run solder into the threads.

"The cross-connectors are now screwed in and the same problem arises in three other places and is similarly solved. Or the two units may be welded or brazed together.

"The 1/2" T's drilled out with a 3/4" drill serve as bearings. Holes should be drilled in the T's for lubrication. These bearings are very sturdy and entirely adequate for these slow-moving parts. Regular 3/4" shafting and collars were used throughout.

"The driving crank contains a slot in which slides a bolt which may be clamped at any position and the end of this bolt drives the pitman bar. A crank range of 0" to 3" (6" stroke) is adequate. At the right end of the horizontal overhead shaft (Figure 3) is a sturdy clamp tightened on the shaft with a setscrew which allows change of the position of the stroke in polishing. The stroke is usually less than one half the diameter of the glass disk on the head; the bar pin should never cross directly over the rotating driving center.

"The yoke which permits the bar pin to be swung out in an arc, up, and back overhead out of the way, was carefully machined from solid material, but a 3/4" self-aligning shaft hanger, if sturdy, should work well in its place."

ONE MORE method of making a pitch lap, this one more especially for a deep-curve mirror but equally applicable to other mirrors, is offered the telescope making fraternity with pitch in their hair by John P. Tyskewicz, 142 Seymour St., Hartford 6, Conn., who foresaw that for a deep mirror enough pitch would be squeezed out to start a taffy pulling party. So he devised his "flapjack" lap, precast and uniform in thickness, allowed to cool, and applied warmed-over afterward.

On a sheet of waxed paper he laid a ring of rubber-insulated, twin-conductor type lampecord as a dam for the pitch.

He melted his pitch and let it cool a little so that it would not un wax the paper by melting the wax, poured the dam level full and left it to cool into a flat flapjack, or disk, of uniform thickness.

While the tool was warming he worked the flapjack loose with a long knife, leaving the dam on.

He next warmed the flapjack with radiant heat (water would prevent its adhesion to the tool), swabbed the tool and flapjack with turps, and lowered the flapjack, still in its dam, on the tool, letting it touch first at the center. Gravity plus thermodynamics did the rest.

Now he removed the dam, wet the mirror with soapy water and worked the lap down to perfect fit in the usual manner.

For making channels Tyskewicz uses a 100-watt soldering iron with V-shaped scoop attached, makes plenty of facets not larger than a tenth diameter of lap, and leaves their ends uncut to retain the rough water longer.

CASUALTIES (1) "I lent one of our engineers an 8" cast iron flat," a reader reports, "to use as a base for crocus cloth to finish a mechanism I discovered the man grinding gate valve disks on the flat with valve grinding compound." (2) Another reader writes: "Some men at a military field borrowed my flat and, when returning it, remarked with a hint of pride and virtue, 'It got pretty badly scratched up, so we refinished it for you.' Suspicious and alarmed, the owner asked what technique was used. The casual reply was, 'Buffing wheel.' (3) A green firm buffed an amateur's mirror, aluminized the ruined figure. At a lawyer's 'suggestion' they settled, \$100, but still felt injured.

WOODEN tubes for reflecting telescopes suffer from one almost unsurmountable objection, according to F. N. Hibbard, Richmond, Va.; their tendency to warp. "A friend of mine," he writes, "made a 10" reflector with a wooden tube and says he has to readjust the mirror every night he uses the telescope. Even a slight warpage produces flares on one side or the other of the star images.

"The problem is not to eliminate atmospheric unsteadiness. There will be more or less of that practically every night. There will not be a dozen nights a year when 75 or 100 diameters per inch of aperture can be used to advantage. The main problem is to eliminate flares and unsteadiness due to the tube itself.

"I would build any telescope up to 2' in diameter of metal, and line the metal with cork or quarter-inch strips of light wood such as balsam or Douglas fir. The metal would give the necessary strength and solidity to hold the mirror in exact position and the wood or cork would keep the metal temperatures from getting inside."

Scientific American

Founded 1845

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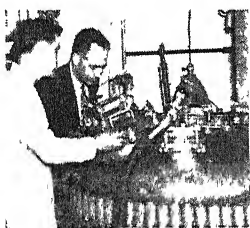
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Our Cover. A 600 gallon batch of casein starts off on its way to become amino acid. The story of this newest branch of chemical industry is told in the article starting on page 62.

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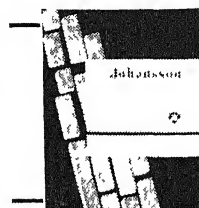
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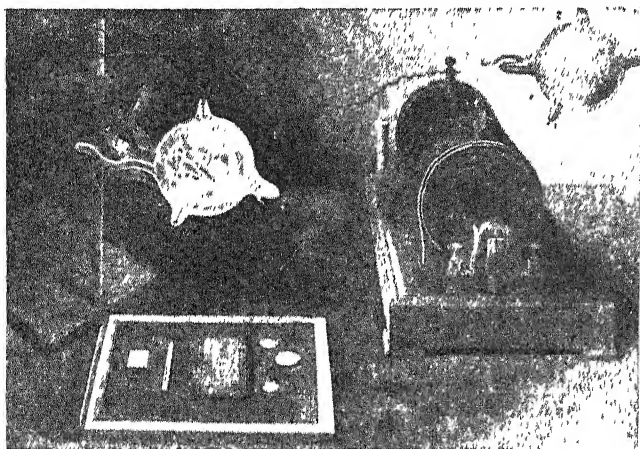
Johansson
GAGE
BLOCKS

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of February, 1896)

X-RAYS — "The discovery of X ray photography by Roentgen will immortalize the physicist who so fully developed it before giving it to the public. . . It is with no small gratification that we are able to put before our readers the



exact details of the experiment, as carried out by Prof. A. W. Wright, of Yale University. He was among the first of the American experimenters. . . The arrangement of the apparatus is clearly shown in the engraving. . . On a clamp support is carried the Crookes tube. . . The excitation was furnished by an induction coil. . . On the table, a few inches below the tube, the sensitized plate contained in an ordinary plate holder was placed, and on its slide of ebonite were placed the objects to be photographed."

LAMP — "A unique bicycle lamp recently illustrated in the *Electrical World* has a small magneto-electric machine, operated by a friction wheel, to furnish current for a miniature incandescent lamp. . . The slightest rotation of the bicycle wheel causes the lamp to glow. Indeed, it would be difficult to ride the wheel slowly enough to maintain equilibrium and not have light."

RUST-PROOFING — "By forming on the surface of iron and steel a double carbide of hydrogen and iron, which is extremely hard and adhesive, protection of the metal from rusting is said to be insured."

SAND BLAST — "Ornamental and fancy castings can be thoroughly and cheaply treated by means of sand blown by compressed air, producing an article which would otherwise require considerable labor to finish. . . Steel is very hard to clean in the usual manner, but yields readily to the sand blast. The outside appearance of the sand box is like that of a vertical boiler. It is fitted with feed valves and sand chambers, so arranged that an air pressure of about 10 pounds per square inch forces the sand through a rubber hose."

GLASS — "What is claimed to be the largest single pane of glass in the country was received at Hartford, Conn., from Belgium recently. It is 12½ feet high, 15½ feet wide, ½ inch thick, and weighs 1,800 pounds."

TROLLEYS — "The Metropolitan Traction Company, of this city, having organized and put in operation their highly developed cable traction system, has now gone a step farther and installed an underground trolley system on

part of its line, with the double view of working the portion of the road now equipped therewith by electricity and of extending it in the near future to other portions of their line"

LIGHTING — "Light may yet be produced in a way less extravagant than that of the incandescent lamp, where the results of an entire horse power of energy are represented by four or five feet of incandescent carbon filament. These hopes are based on induction, for it is in the utilization of alternating or broken currents that the future seems to lie."

MEASUREMENTS — "Refinements of measurements have gone to almost incredible limits. On lenses, curvatures of 1-150,000 inch can be measured. In spectroscopic analysis of mere traces of different elements, fractional wave lengths are read to 1-2,500 millionth of an inch. Professor Dewar in his researches on liquid air attained a vacuum of 1-2,500 millionth of an atmosphere."

INVENTORS — "The Connecticut Yankee still preserves his pre-eminence as an inventor. For the last few years more patents in proportion to population have been issued to Connecticut than to any other State."

PALACE CARS — "The recent growth and development of Brooklyn is largely due to the extension of the surface railway companies' system, whose lines now extend for miles into the country. Last summer the Brooklyn Heights Railroad Company placed several excursion cars in service. These cars were profusely decorated and were furnished with incandescent lamps of all colors. They could be chartered for trips of all kinds, and it was not an unusual sight to see a procession of five of these cars, the first having a band, passing through some of the principal streets."

FROM THE ADS — The Pocket Kodak; The Ingersoll Dollar Cyclometer; Rand Rock Drills, Stereopticons; The American Bell Telephone Company, Jessop's Steel; Carborundum; "Wolverine" Gas and Gasoline Engines; Money Telescopes.

100 Years Ago in . . .



(Condensed from Issues of February, 1846)

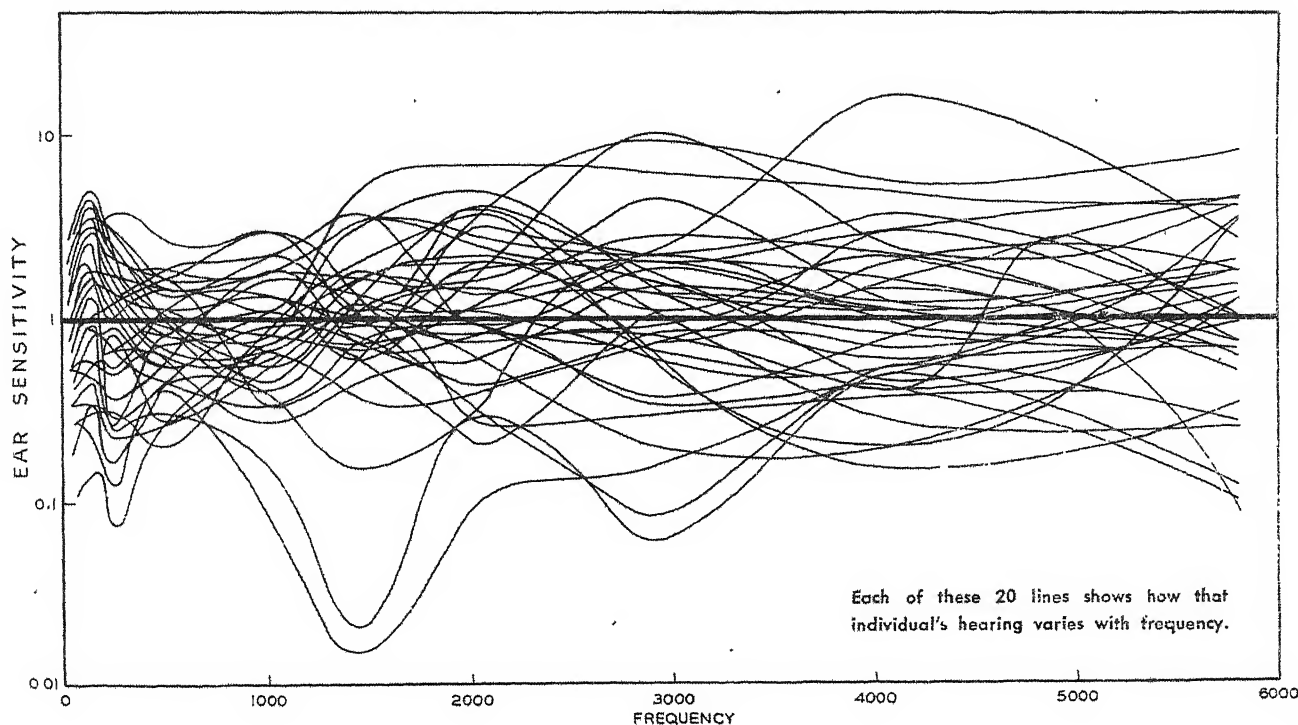
PANAMA CANAL — "The report of engineers sent by the French government to examine the Isthmus of Panama, with the view of ascertaining the possibility of cutting a canal through it has been published. It declares most decidedly for the practicability of the scheme."

FIRE EXTINGUISHING — "An apparatus for the instantaneous extinguishment of fires projects upon the fire a peculiar gaseous vapor, which has a greater affinity for the oxygen of the atmosphere than the burning combustibles, and consequently extinguishes the fire by depriving it of oxygen."

WATER RESISTANCE — "When a body is made to move in, or pass through still water, the resistance of the water against this motion, depends on the position, as well as the extent of the surface which encounters the fluid."

MECHANICS — "Show us the man who would consider it a disgrace to associate with honest, well informed mechanics, and we will show you a worthless ignorant creature, useless to himself and the world, and a disgrace to society."

FROM THE ADS — Portraits in Daguerreotype; The Business Man's Guide and Legal Companion; Locke's Portable Shower Bath; Lap-Welded Boiler Flues; Ever-Pointed Gold Pens; Scythe Stones; Wire Window Shades.



To measure is to know

Twenty-five years ago, one standard of sound power was the ticking of a watch, another was the clicking of two coins; and the measure was how far away the tick or the click could be heard. That test was made in measuring people's hearing, a field of interest to the Bell System scientists because the ear is the end-point of every talking circuit.

Accustomed to exact measurements, Bell scientists proceeded to develop a method of measuring hearing-sensitivity in terms which could be precisely

defined and reproduced. After plotting hundreds of runs like those above, they decided on a particular sound intensity, representing an average "threshold of hearing," as a starting point.

The sounds delivered by a telephone line had previously been evaluated by listeners who compared their loudness with that of a standard source. There were wide variations in ears, as the chart shows, so the engineers replaced them by electrical instruments. When later their associates developed the

Western Electric radio and public address systems, the necessary measuring circuits were promptly forthcoming. Addition of a standard microphone made a noise meter, widely used in quieting airplanes and automobiles.

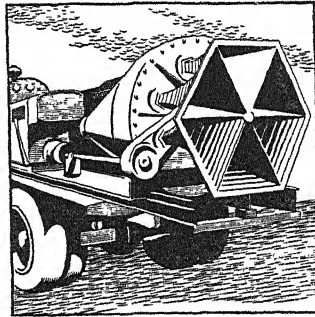
"Through measurement to knowledge," said a famous Netherlands scientist. The principle finds wide application in Bell Laboratories, whether the quest be for a way to measure sound, a new kind of insulation, or more economical telephone service.



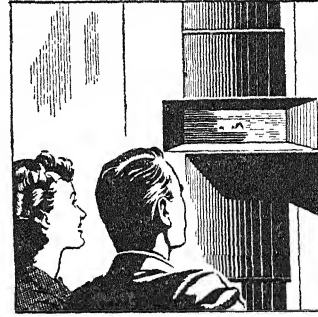
Hearing was first measured reliably by engineers in the Bell Telephone Laboratories



For good reception, program loudness must stay within certain limits. Volume-meters help to hold it there



From the throat of this mighty air-raid siren comes the loudest sustained sound ever produced



Visible Speech, result of telephone research, turns sound into "pictures" that the deaf can read

BELL TELEPHONE LABORATORIES



Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service

Previews of the Industrial Horizon

A DAY'S PAY FOR . . .

A SCREWY individual, speaking from the juvenile standpoint, is one who does not conform, in one way or another, with the rest of the crowd. So, from the same standpoint, James F. Lincoln, of Cleveland, Ohio, is probably one of the screwiest of individuals in industry today. And all Mr. Lincoln is doing is operating a business on the basis of paying his employees what they are worth.

Such an industrial plan of operation must be too simple. It goes against all the ideas of the efficiency experts, the union demagogues, the big-domed statisticians, and the brain-trust (but not trusting) Government analysts who would regulate everything for the greatest good to the clamorous few.

But Mr. Lincoln's industrial philosophy works. For some 20 years his employees in the electrical welding equipment business have had these advantages over other workers. No worker has been laid off because of lack of work; no reduction has been made in individual wage rates; every employee has received a steady income; there has been no labor trouble that has resulted in the loss of a single hour of time; wages have increased steadily, more jobs have been created. And while all this has been going on, the price of Lincoln's products has decreased more than 50 percent.

It must be all wrong. Lincoln is operating on the basis of free enterprise. He is doing things the way our forefathers wanted them to be done. He is doing things the American way and getting them done. But he is doing them the simple way—the way in which labor unions say they shouldn't be done. He is paying each worker what he is worth. And the result is that his workers produce more for less money. Simple, isn't it? Of course it is—it's too simple. What will work for a single company could work for the entire country. What could work for the entire country would work for the whole world. But Lincoln's plan is too elementary. It leaves out of the picture the run-everything boys, the big brains, the economic experts. Seemingly, all too few people want to work for what they are worth. That's too little pay! And in those last three sentences lies the crux of labor troubles and the problems that face industry today. The sooner we return to the fundamentals, the basics of the American way, the sooner labor unions and the run-everything boys will have to take a back seat and the sooner industry will be able to solve its own problems.

SHARE-THE-PATENTS

THE SHARE-EVERYTHING groups are at it again. Now it is agitation to share-the-patents. Self-appointed saviors of the small business man would force licensing of patents in order, they say, to avoid monopolies. Here is another of those dangers to American business which seems credible on the surface but carries a real threat when studied carefully. The 17-year exclusive rights to an invention, granted by our patent laws, is one of the greatest incentives to competitive industry; destroy that exclusive right and you destroy competition. Industry—big and small—is built on patents, not on monopoly. To force a licensing system on patent holders is to force a sharing of property by those whose diligence produced it, with those who were too lazy or lacking in initiative to produce for themselves.

PATENT SUPPRESSION

ONE of the boogies that is raised by the share-the-patents group is that of patent suppression. Monopoly is fostered, they say, by the suppression of patents that would create competition or would vitiate existing production plans. Therefore, they cry, compel patent licensing and eliminate patent suppression. This is a point that has often been brought up; the belief in patent suppression is far too wide spread. Thus far, to our knowledge, no positive proof of wil-

By A. P. Peck

ful patent suppression has ever been brought forth. Loose talk, based on loose thinking, can do a lot of harm when applied to the subject of patent suppression. It is the kind of talk that should be answered by "Put up or shut up!"

TELEVISION PROGRESS

LEAD ITEM on this page in our January number concerned new advances in television equipment. Since then, RCA has demonstrated still more brilliant receiving images that can be viewed in a fully-lighted room. Basic to the new images is an aluminum-backed cathode-ray tube screen which decreases internal reflection and increases picture contrast. RCA also demonstrated full-color television, at the same time stating that the mechanical methods used lacked perfection and that color television by a satisfactory electronic means was still five years in the future. Television reception for the general public is an immediate possibility (RCA will be in production with receivers within the next six months), but their engineers admit that obsolescence of receiving equipment is a big problem.

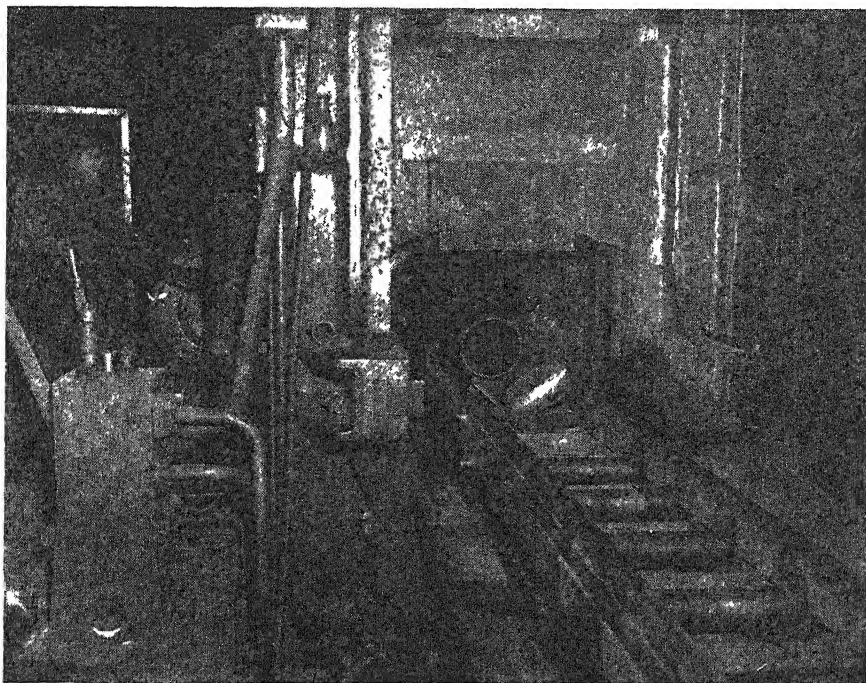
Just as radio in the early 20's heralded a new and mighty industry, so does television today. But many a bleached skeleton is going to line the path of progress. Brains, dollars, and faith must back the development. And the public must want the benefits of television and be willing to pay for them if the industry is to prosper.

ADHESIVES ON A GRAND SCALE

THOSE who still look askance upon synthetic resins as a reliable bonding agent for wood will find many of their questions answered by work going forward on the 200-ton flying boat nearly completed by the Hughes Aircraft Company. Here, a group of adhesives—liquid and film—are being used to make the millions of glued joints required in the mammoth aircraft. Tests extending over a three-year period have proved the efficacy of the bonding materials. And the lessons learned will flow readily into other industries, from the production of boats and furniture to pre-fabricated houses and junior's toys.

FOR FUTURE REFERENCE

RAISINS reported to have better flavor are now being produced in a matter of seven minutes by drying with infra-red, as compared with some 17 hours by hot-air methods. . . Air freight is growing by leaps and bounds (or should we say hops?); food products, flowers, electric irons, radio sets, machine parts, and other dissimilar cargoes are flying to destinations, helped by new low tariffs and simplification of bills of lading. . . Five million dollars of government money (peanuts by some criteria) is going into a gamble that alumina can be produced cheaply from Oregon clay; ultimate gain in view is complete independence of the United States in aluminum production, if an international emergency in the future should cut off ocean-borne supplies of bauxite. . . The whole aluminum picture today is a peculiar one; production capacity is greater than national needs, yet scrap aluminum is scarce. . . The scrap gap can be filled—more than filled—by obsolete and disabled war planes, if the problem of getting them to smelters can be solved; secondary aluminum, made from scrap, must sell for two-thirds the price of primary aluminum if its uses are to be fully exploited. . . New uses for cotton fibers and by-products are being eagerly sought by the Department of Agriculture.



Nickel alloy tubing, formerly made by piercing and cold drawing, leaves the extrusion die. Temperatures as high as 2200 degrees, Fahrenheit, may be used.

METALS IN INDUSTRY

Extrusions Push Ahead

Product Designers and Manufacturers Will Find New Raw Materials in the Extrusions that Are Now Available. Recent Advances in Extrusion Techniques have Opened this Materials-Forming Method to Many of the Stronger and Tougher Metals that Formerly Could Not be Extruded

By FRED P. PETERS

Editor-in-Chief, Materials & Methods

EXTRUDING of metals has been described in non-technical terms as a process of "squeezing" hot metal through an orifice so that it emerges thinner and much longer than it was originally. This essentially accurate description strongly suggests that the process is limited to the soft (or "squeezable") metals like lead and tin and that stronger and harder materials had best be fabricated by some other methods.

Actually this situation was generally true until the past few years. The metals commonly extruded were lead, tin, brass, and bronze—and more recently aluminum and magnesium. Strong copper alloys, nickel alloys, stainless steels, and even zinc were not commercially available as extrusions. But the war years witnessed the development of larger extrusion presses and of special press and die designs that have

placed these stronger, tougher metals on the market in extruded forms. An entirely new series of raw materials has thus been presented to the product manufacturer.

Strictly speaking, the term "extrusions" covers several classes of products—very long pieces of round, tubular, or special-shaped cross sections (regular extrusions), as well as relatively short cup-shaped cylinders closed at one end and open at the other (impact extru-

sions). Although light metal impact extrusions are extremely interesting because of their increasing importance as competitors for stamped and drawn parts, they are a separate story by themselves and will not be further discussed here; primary concern now will be with the "long-drawn-out" extrusions and their recent progress as it affects industry in general.

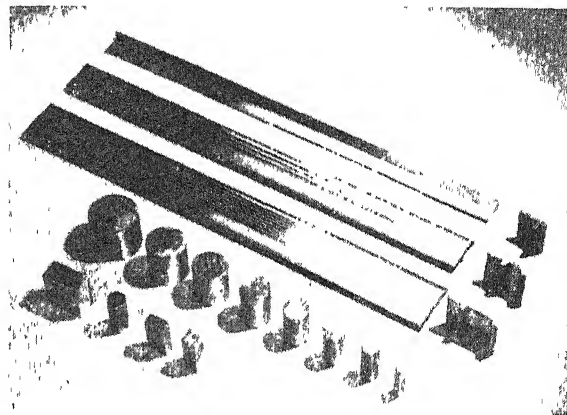
A good picture of the state of development of soft metal extrusion

is found in the manufacture of lead pipe for chemical (sulfuric acid) processing equipment. Traditional lead-pipe production commonly resulted in eccentricity or variations in wall thickness, inclusions, laminations, and internal longitudinal welds, all of which reduced the resistance of the pipe to its corrosive environment. Modern presses, however, eliminate most of these drawbacks just by being much larger and by the provision of guided columns and other aids to geometric accuracy.

NO LAMINATIONS — Thus, one large Robertson lead extrusion press at an American Smelting and Refining Company plant has a 1500-ton capacity and can make, for example, a continuous 22-foot-long piece of 12-inch-diameter, $\frac{3}{4}$ -inch-wall lead pipe weighing 3250 pounds without laminations or welds anywhere along its length. The lead press operates vertically, the molten lead being poured around a steel core placed vertically in the center of the press cylinder. After the lead is solidified the ram and cylinder are forced upwards through a die fixed to the upper part of the press. With the older, smaller presses, such long lengths could be produced only by introducing several charges of molten lead, with consequent "laminations" along the length wherever the lead charges met.

Modern extruded lead is considered superior by the chemical industry because its freedom from laminations and welds does away

Extruded shapes in zinc alloy
Long extrusions are sliced
to make intricate small parts



with points of local chemical attack and areas of mechanical weakness that shorten the service life of lead extruded in smaller, less accurate presses.

Lead extrusions are common, but in the case of aluminum bronze, extrusions are not common and their production was a notable achievement which made available all the strength, hardness, and corrosion resistant advantages of this copper alloy in a new form.

At an Ampeco Metal plant, aluminum bronze is extruded on a Schloemann horizontal hydraulic 2275-ton press. Rods, tubes, and shapes are produced in diameters up to about five inches and lengths up to 14 feet. The best type of aluminum bronze for extrusion appears to be the high-iron high-aluminum type containing 2½ to 5 percent iron, 8½ to 15 percent aluminum, and the remainder copper.

The press for producing aluminum bronze extrusions consists essentially of a ram, a hot-billet container with an opening at each end, a die and holder with a taper fit so as to be self-aligning when seated into one end of the container, a gate lock which holds the die and die-holder firmly against the pressure developed in extrusion, a ram for exerting the pressure against the rear face of the billet, and a shear for severing the butt or unextruded portion of the billet at the face of the die. The latter, with its holder, is retractable from the container.

ALUMINUM BRONZE—Tube extrusion of aluminum bronzes employs slightly different attachments, particularly a piercing attachment consisting of a mandrel and holder actuated horizontally and centrally through a hollow ram. In tube extrusion the billet is placed in the container against the face of the die. The ram remains stationary, sealing the rear of the container, while the mandrel pierces the center of the hot billet; a cylindrical slug of metal is ejected through the die and then continues to advance

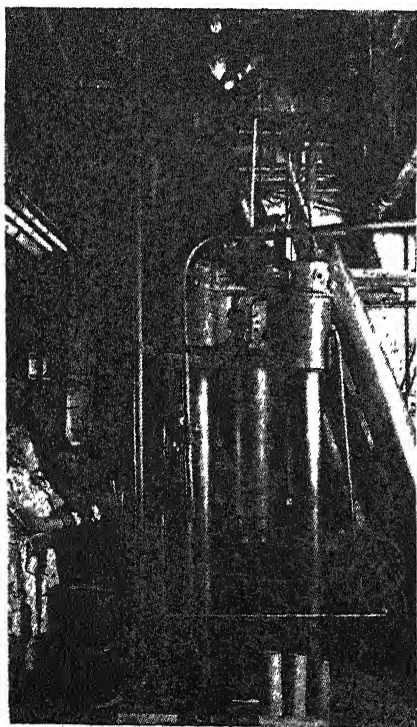
along with the ram, the pressure of the latter causing extrusion while the mandrel and die form the inside and outside surfaces of the tube, respectively.

The most important requirement in making aluminum bronze extrusions, especially tubing, is to maintain press alignment as nearly perfect as possible. Worn containers, wear plates, guide keys, rim slippers, pressure rings, or column nuts must be corrected or replaced systematically to avoid high scrap losses. Die wear and maintenance is also a problem; dies are made of 10 percent tungsten tool steels, which satisfactorily resist the wear at the high temperatures to which extrusion dies are subjected.

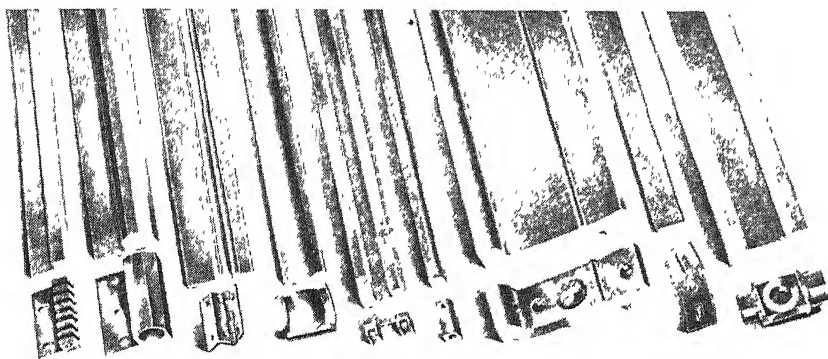
Extruded aluminum bronzes are used for aircraft engine parts, landing gear components, and controllable or variable pitch propeller parts, their applications are certain to extend to other industrial products such as machinery parts, bushings, sleeves, bearing elements, forging-rod for the manufacture of bronze forgings, bar stock for making screw machine products, and so on. The advantages of extruded aluminum bronze over production by other methods are the finer structure and greater strength as compared to aluminum bronze sand castings, and a frequent saving in material, tool cost, and finishing expense as compared with forgings and die castings. The surface finish of extruded aluminum bronze is similar to that of a rough-machined material.

ZINC EXTRUSIONS — For many years the possibilities of extruded zinc and zinc alloys have been appreciated, but the difficulties in making the product prevented its commercial development. During 1945, however, the first commercial extrusion of zinc alloys and of high-purity zinc metal was achieved by the White Metal Rolling and Stamping Corporation, and a new industrial raw material was made available.

Zinc extrusion is done on conven-



This vertical press extrudes zinc shapes from billets in foreground



Use of formed mill stock (above) in manufacture of irregular shaped articles (below) often eliminates complicated machining operations and wasted material

tional vertical presses such as are used for magnesium and aluminum. Round rods 3/16 to 2 inches in diameter, as well as flats, squares, hexagons, and irregular shapes have been extruded. Tubing can be manufactured in diameters up to 1½ inches with walls at least ⅛ inch thick. Zinc extrusions may be as long as 14 feet.

In the vertical extrusion press used at White, the die is in the lower end of a tubular ram. A cast, hot billet, 5 inches in diameter and about 18 inches long, and weighing 85 pounds, is placed in the cylinder. The latter, on the lower platen of the press, is elevated and applies the heavy pressure needed for extrusion, which varies according to the shape of the section being produced.

The zinc extrusions have somewhat higher tensile strength and impact strength than zinc alloy die castings and are therefore expected to find use in mechanical applications such as rods or tubes for screw machine production. Zinc is a highly machinable material and the availability of long lengths of strong zinc alloys held to close tolerances and with the good surface finish that is characteristic of extrusions is expected to be welcomed by manufacturers of machined products generally.

Actual applications of zinc extrusions are still limited because of their very recent availability. The Navy has used large amounts for "wasting pencils" in heat exchangers which are used to inhibit the corrosion of steel surfaces in sea-water through the preferential electrolytic corrosion of the zinc in contact with the steel. A similar application is the cathodic protection of steel pipe buried in the earth through the use of extruded zinc.

The white color of zinc alloys may make them useful for screw machine products where brass may be considered more expensive or where aluminum may be thought too difficult to solder or plate. Welding rod and wire for metallizing are other

suggested applications. Furniture moldings and the like can be extruded and may compete with equivalent rolled sections on a cost basis. Door saddles and shapes designed for molding in terrazzo floors are possibilities.

Very large presses for the extrusion of aluminum and magnesium have been built in recent years and are in current use. These metals lend themselves exceptionally well to extrusion because of their hot workability. Aluminum and magnesium extruded products find a ready and wide market because of their lightness and rigidity and because both materials are so easily machined. The aircraft industry, of course, has been the heaviest user but peace-time applications are expected to include structural components of railway, truck, bus and trailer equipment, textile machinery, architectural and building sections, moldings, and so on, and as raw material for mechanical parts to be produced on automatic screw machines.

TAPERED SHAPES — "Stepped extrusions" in aluminum are a recent development of especial interest to designers and production men. A stepped extrusion increases in cross-section in steps from one end to the other. The chief advantage is in the production of long tapered shapes whose cross-section changes gradually from one end to the other. Although considerable machining is required to reduce the steps to a smooth taper (for example for aircraft "spar gaps" or wing beams) the machining is still much less than if the part were to be initially produced by conventional extruding or rolling.

In addition to the aircraft field, applications will develop wherever a long tapered light metal part—for example, masts for small boats, flag poles, metal furniture parts, and similar items—are required. A general-purpose extrusion alloy, 63S, is now widely used because of its high

strength, corrosion resistance, brilliant color, and freedom from cloudiness after anodizing.

Not quite so large as the largest aluminum press (5500-ton) but still respectable in size is a 4000-ton Hydro-Press, Inc., unit used for extruding high melting-point metals such as nickel, Monel, Inconel, gilding metal, and copper tubing. Previously, tubing made of these materials was produced in this country by piercing and cold drawing, but some of the alloys—for example, "K" Monel—cannot be pierced. Using the 4000-ton extrusion press, tubes of nearly nine inches outside diameter and eight inches inside diameter can be produced in any of these materials.

The press is a horizontal hydraulic unit. One of its chief features is a preliminary cupping operation on the hot billet, causing the metal to extrude back over the mandrel without loss of the metal slug that would otherwise go through the large die (as with aluminum bronze extrusions, described above). After cupping, the billet is lifted out and the die placed against the container, permitting piercing and extrusion. Temperatures as high as 2200 degrees, Fahrenheit, are used when working some materials on this press.

NEW USES—The outstanding application of the extrusions made in this press has been revolving shell bands made of gilding metal for the Navy, for which the tubular extrusions were simply sliced into shell band sizes. Beyond this, the nickel alloy extrusions are expected to find many applications in heat exchanger, process industry, and sea-going equipment where their resistance to corrosion and high temperatures and their excellent mechanical properties can be used to the betterment of the final product.

During the last four or five years the extrusion process has moved ahead by leaps and bounds. Because of it tubing is now available in materials that could not be produced as seamless tubing a few years ago (for example, "K" Monel). The advantages of extrusions—strength, close tolerances, good surface finish, and availability in a variety of cross-sectional shapes—have now been extended to materials such as Inconel, aluminum bronzes, and zinc alloys that were formerly commercially available only in other forms. Today's product designer and parts manufacturer is finding in extrusions a new type of raw material that can be adapted advantageously to the requirements of many and varied peace-time products.

Plastics In Radio

A Large Percentage of the Radio Receivers to be Made During the Coming Year will Use a Variety of Plastics in a Variety of Ways. Moldings, Extrusions, Castings, and Wire Insulations All Find Places in an Industry that Faces a Greatly Expanding Future

By CHARLES A. BRESKIN

Editor, *Modern Plastics*

TWENTY-FIVE million radio receivers to be produced in the first full post-war year! Such are the expectations of the radio industry. This estimate is based upon a belief that the market for small radio sets is a long way from saturation because many pre-war sets are either worn out or obsolete, and because Americans generally use more than one radio set per family. At present, 30,500,000 homes in the United States—83.5 percent of all homes—have about 46,300,000 radio sets of which 7,100,000 were not in working order in April 1944, according to WPB surveys.

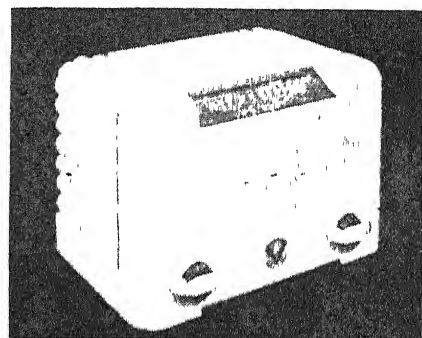
To a considerable extent, much of the growth of the radio industry has been due to the development of better plastics and to the better use of available plastics. This fact is backed up by the accompanying chart which shows a steady increase from 1937 through 1941 in the number of plastics cabinets produced.

The figures are from the production records of the radio industry; the estimates are those of radio manufacturers based on their own records. And these men further estimate that between 70 to 80 percent of the table and personal radio models sold in 1946 will have plastics cabinets.

There are a number of reasons for the widened use of plastics in radios. Most important of all, perhaps, is the

general improvement in cabinet design which has resulted from the closer co-operation of radio makers and plastics molders in developing good looking housings with the proper structural qualities. The development of a loud speaker using Alnico No 5 magnets has also contributed to the increased use of plastics materials. This unit, which is much smaller, lighter, and more efficient for use in small cabinets than the older speakers, is relatively unaffected by the housing in which it is placed.

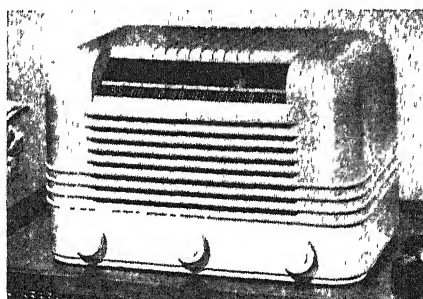
The radios that are even now hitting the market incorporate a number of other improvements, many of which are made of plastics material. Take, for example, Viewtone's five-tube model housed in a molded urea-formaldehyde case. It makes use of an engraved vinyl dial placed near the top of the cabinet where it can be seen from any po-



Viewtone: Molded case

sition. Some manufacturers RCA among others—use printed rather than engraved extruded vinyl strips for their dials. Of course, more and more of the electrical wiring is vinyl coated, but this also holds true for other industries besides radio.

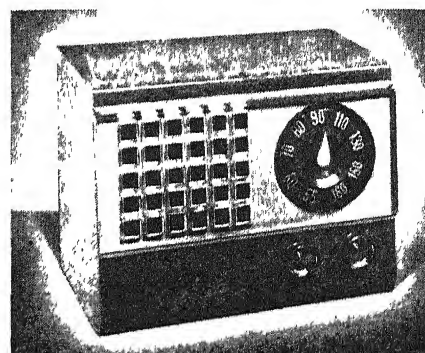
Any number of companies are beginning to use two differently colored plastics materials in their cabinets. Usually, the case is of one color and the speaker grille or louvres of another, the two pieces being produced separately and attached together in assembly. One of Emerson's table models features a cast phenolic housing with a compression-molded grille of methyl methacrylate. Then there is Garod's cast phenolic case with contrasting louvres, and Stewart-Warner's two-



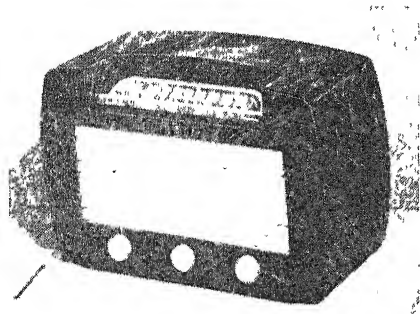
RCA: Printed plastics strip dial

Year	Total radio sets (including phonographs, automobile sets, and table models)	Table models	Plastics Cabinets
1937	8,083,000	3,580,000	904,000
1938	7,141,000	3,474,000	1,420,000
1939	10,759,000	5,400,000	3,200,000 (est.)
1940	11,859,000	5,516,000	3,600,000 (est.)
1941	13,642,000	5,988,000	4,000,000 (est.)
1942	4,307,000

Tabulation showing increased use of plastics cabinets for radio receivers



An Emerson receiver with cast housing and compression-molded grille



Stewart-Warner's two-toned model

toned model in which both the housing and grille are cast from phenolic.

Color contrast is also being achieved in some plastics radio cabinets through the simple expedient of spraying one color over masks on housings of another color, molded in a single piece. This procedure is less expensive, of course, than the method described in the preceding paragraph.

Perhaps the newest and most unusual plastics application in table model radio sets is a molded backplate. Emerson Radio and Phonograph Corporation have developed this plate which it plans to use in all its small radios in place of the older fiber boards. Some of these back covers are compression molded of phenolic or urea while others are injection molded of polystyrene.

Their adoption by this company is in line with its increased use of plastics materials.

There are, of course, many other plastics parts in the average radio receiver. Thus, plastics are standard for tube bases, coil forms, capacitors, insulation bushings, sockets, terminal strips, and, as mentioned before, wire insulation.

The overall picture of the future of plastics in the radio industry is a bright one, indeed, and one which accurately portrays the versatility of these synthetic products. Their multiple usefulness—brought about through ease of fabrication, electrical characteristics, strength, beauty, and durability—make them particularly adaptable to the widely diversified demands of radio set construction.

Garod: Cast case, contrasting louvres



PLASTICS HANDLING

Assists in Reconditioning of Service Men

THE value of plastics in the reconditioning work the Army is carrying on in hospitals throughout the country may be judged by the fact that a course for plastics technicians is now being taught to Medical Corps personnel at the Ordnance School at the Aberdeen Proving Ground. Here enlisted men and women from all kinds of Army hospitals are being trained to handle the material so that they, in turn, can instruct wounded veterans in this medium.

The Army's use of plastics began some time ago when pieces of acrylic were among the scrap materials received from plane factories for occupational therapy work. These transparent plastics offer one distinct advantage over wood, a traditional material for this work. They are cleaner and cause less dust. This is extremely important in the case of patients suffering from tuberculosis or similar diseases.

There is a wide range of exercises

involved in making plastics articles. At the simplest level there are the cigarette boxes. Flat pieces, cut to the proper sizes, are given to bed patients who glue them together. When the patient is strong enough to start, corrective and reconditioning work is undertaken. Then ordinary tools are modified in order to suit a particular injury and to give a specific exercise.

In addition to its value in the physical reconditioning of men with muscle and nerve injuries, work with plastics has a therapeutic value for other patients. It furnishes activity and interest to counteract the boredom and depression to which patients may be subject.

NYLON DRESSING

Used to Cover Severe Wounds and Burns

ONE of the unique medical discoveries of the war involves the use of woven nylon as a dressing for wounds and burns.

Surgeons have long been plagued by the tendency of surgical dressings to adhere to raw wound surfaces. All of the problems involved

seem to be allayed with the introduction of nylon surgical gauze which evolved as a result of experiments by Army surgeons with dressings improvised of nylon window screening. Sections of the screening, after being cut, washed, and sterilized, were used in both the operating rooms and in the wards. It was tested under both field conditions and in the finest modern hospitals constructed by the Army in the Russel Islands, in Espiritu Santo, in the New Hebrides, and in Luzon.

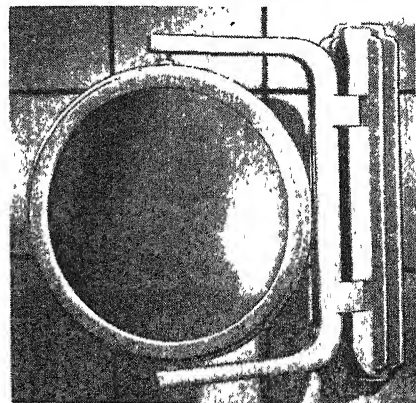
A total of 60 cases were treated with these nylon bandages and kept under observation. Surgeons and patients were pleased at the ease and freedom from pain with which these nylon dressings could be changed. Since the screen was flat and slightly stiff, the granulation tissues in irregular wound cavities would grow out to the screen to form a smooth, level surface—ideal for the placement of skin grafts. The absence of surface bleeding as a result of dressing changes was remarkable and fewer sponges were required. There were no cases of skin sensitivity or irritation attributable to the nylon screen.

The fabric that was finally selected as a result of this work was an undyed, unstiffened, smooth, soft, opalescent-white, glossy cloth with a weave of strands of twisted nylon thread. When a stiffened cloth is desired for covering small wound cavities and skin grafts, a finish of 2 percent solution of nylon, type 6, dissolved in isopropyl alcohol, is specified.

MIRROR FRAMES

Easily Converted to Peace-Time Style

THE INDUSTRIAL switch from war to peace has caused many a headache, but not for the Consolite Corporation at least so far as their two-sided mirrors are concerned. Developed for the Navy, the mirror was designed with an inner frame



Plastics bracket holds the mirror

which could be fitted into an injection-molded Tenite II swivel wall bracket just as well as into the heavy metal wire frame that made it practical for use by the military. In its war-time garb, the mirror is suitable for campers or others who make their temporary home outdoors, since it can be propped up on a shelf at any desired angle or hung from a nail. And in its civilian dress, affixed to the bathroom wall, it can be adjusted to any angle or turned completely around to reveal the magnifying side. Nasco Plastics Division of National Organ Supply Company does the molding.

PLASTICS BOXES

*Display and Protect
Badges and Jewels*

DECORATIONS are meant for display, whether they are badges of honor, such as the Purple Heart, or sparkling jewels. Yet, too often, they are shut away from sight in conventional velvet or satin lined boxes most of the time.

All this will be changed when Lucite and Plexiglas boxes are adopted by jewelers just as they have been accepted by the Armed Services for all Army and Navy medals and decorations. The transparent tops of these cases put decorations on permanent display, set off by the solid blue of the bottom half of the boxes.

There is another novel feature of these injection-molded two-piece plastics boxes. A small hole in the shape of a keyhole is molded through the solid blue bottom, approximately three quarters of the way toward the end that would be termed the top should the case be stood on its edge. This opening makes it possible for the owner of the decoration to hang the box and its contents on the wall. There it can be on permanent display, yet be protected from dust and moisture.

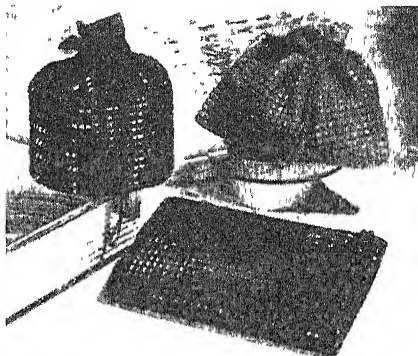
PLASTICS DIAMONDS

*Are Injection Molded
Through Cloth*

FLEXIBLE sheets of plastics, fabrics woven from plastics monofilaments, and fabrics coated with plastics are an old story to the handbag manufacturer. Now he has a new plastics medium in which to express himself—a cloth wherein plastics faceted diamond shapes are injection molded right through the material. By a special molding technique developed and patented by Plastocraft Company, cellulose acetate is forced through the cloth into a mold which creates the desired pattern. Then the finished mats, measuring ap-

proximately 9½ by 15 inches, are cut, sewn, and shaped into handbags.

In addition to its novel appearance, this material has a number of advantages. Since the individual plastics beads are integral parts of the fabric backing, they won't chip or drop off and are sufficiently close together so that dirt can't gather



Plastics molded through cloth

between them. Moreover, there is no lacing between the cubes to soil or break. The plastics surface is colorfast and the material is flexible, light in weight, and capable of withstanding rough handling.

TRAY COVERS

*Aid Inspectors When Made
Of Transparent Plastics*

PLASTICS have found a new outlet in the cigarette manufacturing business. At the factory of Stephano Brothers, Lucite is being used for tray covers in packing machines. The advantage of plastics in this application is that inspectors can easily see through the methyl methacrylate sheets and spot damaged cigarettes before they jam the machines.

WOOD AND PLASTICS

*Combine in Mass Production
Of Household Objects*

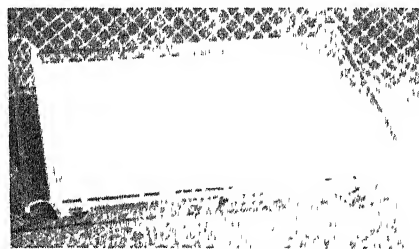
THE EASE and grace with which transparent acrylics combine with other materials is not the only point of difference in a new line of household accessories just introduced by the Plastics Manufacturing Company. These include trays, wastebaskets, and magazine stands—to mention but a few—designed by Sundberg and Ferar, industrial designers who developed these items so that they could be mass produced on machines formerly devoted to the manufacture of blown acrylic and molded phenolic aircraft parts. The object was to turn out the articles in the assembly-line manner with a minimum of plant retooling.

The designers also envisioned the

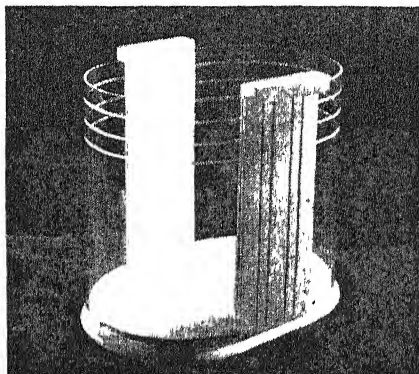
production of accessories that would fit any interior decoration or color scheme. This they succeeded in doing, partly because of the adaptability of transparent acrylic sheet and partly because of the many different colored woods they employ. Sometimes maple is selected; again, mahogany or blond wood is employed.

The serving tray and waste paper basket are typical of this new line. Acrylic sheets can be formed readily into complicated shapes, but containers like the waste basket are achieved in wood only after painstaking machine and hand work. It was logical, then, to make the curved sections of transparent plastics and the base and straight sides of wood.

The acrylic material arrives at the plant in long sheets to be cut and shaped on a special high speed tool. The plastics cut-out is then heated to approximately 240 degrees, Fahrenheit, and placed on a forming die where it cools into shape. Since the acrylic sheet is heated to such a high temperature, it retains its shape indefinitely even should the article be placed near a radiator as it well might be in the home. Plastics cement is used to attach the Plexiglas or Lucite parts to the wood. This eliminates un-



Examples of possible combinations of plastics and wood. Curved-end serving tray (above) and wastebasket (below)

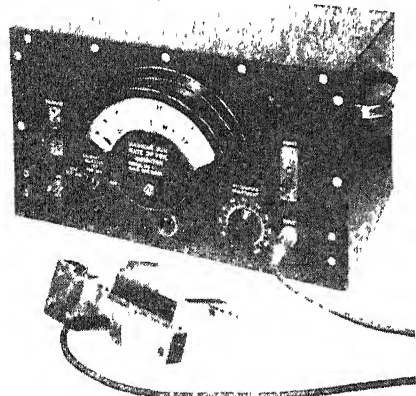


ightly fastenings that often mar an otherwise attractive design. When a frosted effect is desired in a piece of acrylic to enhance its decorative charm, the transparent plastics is run lightly over a high speed tool which has been developed specially for this purpose.

Electronic Inspection

WHEN the exacting demands of the battle-front called for an unvarying quality in the finished products, refinements in existing testing and inspection techniques became mandatory. The percentages of rejects encountered when many firms first undertook military production were staggering and engineers soon looked to electronics for methods of speeding up such inspection, making it more efficient and as automatic as possible. Although there are a great many applications of electronics to inspection and testing, representative examples can be selected which have the broadest implications to future production.

Telephone handset receivers, loudspeakers, and microphones require the best in inspection methods



Operating rates of machine tools, or other rapid-moving equipment, may be readily checked with an adaptation of this electronic gun-fire rate tester

because they have performance specifications with comparatively narrow tolerance limits. This makes it necessary to check the performance of each unit produced.

An electronic tester, developed by Great American Industries, Inc., that produces the output-*vs*-frequency curve of these units on a cathode-ray tube screen, is the most practical solution to this particular production testing problem. The sound-producing devices are energized by a signal produced by a variable-frequency generator, so that the testing sound changes grad-

Visible Quality Curves Traced on Cathode-Ray Tube Screens Provide Inspection and Testing Equipment that Eliminates the Human Factor. Increased Reliability in Precision Mechanical and Electrical Units May be Obtained by Applying Proved Methods of Electronic Checking

By VIN ZELUFF

Associate Editor, *Electronics*

ually from a low hum, through the entire audio range, to a high-pitched squeal. A crystal microphone serves as the artificial ear that listens to these sounds. The microphone output is amplified and made to move the electron beam of the cathode-ray tube vertically on the screen by an amount that is proportional to loudness, while a mechanical linkage sweeps the beam horizontally in proportion to frequency. The result is the response curve of the instrument under test, traced as a glowing curve on the screen.

For tests of microphones—sound pick-up devices—the procedure is reversed, with the generator feeding a loudspeaker that serves as an artificial sound source having known

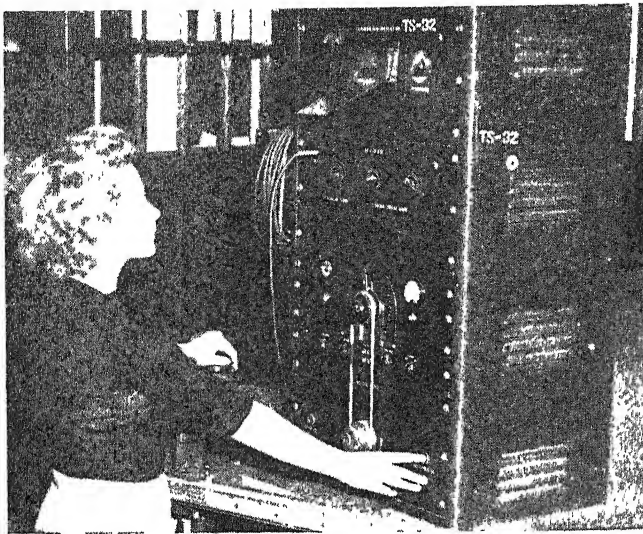
characteristics, while the test microphone is arranged to listen to the sounds. Curves obtained in this way tell how well the microphone picks up sounds.

By shading all parts of the cathode-ray tube screen above and below two curves that represent permissible limits, even unskilled operators can tell at a glance whether a unit passes its test. For good units, the entire response curve will be visible, while for bad units a part or all of the electronically traced curve will be hidden behind the shaded areas.

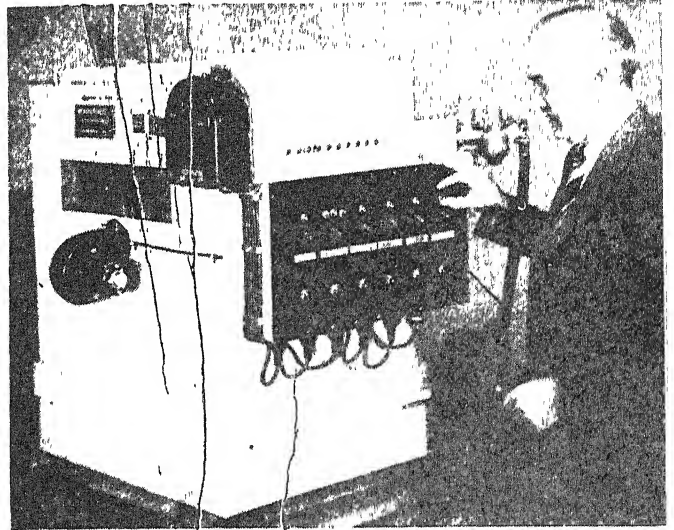
This electronic curve tracer has withstood the rough handling of assembly-line usage for a period of over five years while testing well



An electronic balancer, combined with a stroboscopic light to measure speed of rotation, detects the amount and location of unbalance in a rotating part



Telephone handset receiver, in tester's left hand, is tested with sounds of known value. Its response curve is electronically reproduced on the cathode-ray tube screen within the funnel-like light shield.



Plastics and rubber materials undergo a high-speed weather-resistance test in this machine. Ten times faster than nature, the device uses electronically actuated instruments for "spot" production checks.

over a million units, thus certifying the ability of even complex electronic equipment to take punishment in a factory. Other quality control applications for which it is suited include production testing of radio receivers, hearing aids, phonograph amplifiers, dictating and transcribing machines, magnetic wire recorders, and a host of additional acoustical devices.

CRACKS IN METALS—Determination of the quality of a metal product has frequently been a laborious process where it has been necessary to rely on fatigue tests and the study of micro-sections of samples. Such procedure is slow, costly, and conducive to waste in production. A new solution to the problem of high speed production testing for cracks in metal wire, tubing, and bars is based on the electrical characteristics of the metal under test. A compact electronic instrument has been designed for this purpose by Salford Electrical Instruments, Ltd., a subsidiary of General Electric Company, Ltd., of England. In this instrument, a coil is arranged in an electronic oscillator circuit so that it induces eddy currents in the test sample at right angles to its axis. Then, if the frequency is such that the current penetration is deeper than the deepest crack, the effect will be to provide a short-circuited turn and an effective variable resistance in the coil, which will act like the secondary of a transformer transferring its load to the primary. If the oscillator frequency is now measured, using a crack-free sample to act as a short-circuited turn, the frequency will be found to change because of the change in the oscillator inductance when a crack in

the piece under test enters the field of the coil.

A portion of the oscillator voltage is passed through filter circuits and an indicating instrument so that a variation in frequency, caused by a crack, has the effect of causing a large variation in output voltage as shown on a meter. To avoid worker fatigue and to insure against missing short flicks of the meter pointer, a neon lamp flashes at the same time.

The fact that cracks are rarely uniform in depth for more than a fraction of an inch, or may be full of oxide, has not been found to affect the operation of the instrument seriously. The instrument gives indications of cracks from 0.0005 to 0.25 inch deep. The lower limit is set, not by the apparatus, but by the surface condition of the sample. Material from 0.125 to 0.5 inch and from 0.5 to 6.0 inches in diameter respectively can be tested in two standard instruments.

To make the operation entirely automatic, a relay in the anode circuit of one electronic tube operates a small compressed-air paint sprayer, which marks the faulty material over the crack. The relay closes when the neon lamp flashes.

BALANCE TESTING — Production line testing of tiny parts that rotate at high speed, and must therefore be accurately balanced, is another job where electronic tubes far outshine the human senses.

In the electronic balance-tester developed by Gyro-Balance Corporation, the rotor to be tested and corrected is mounted on a seismically suspended platform where it is brought up to speed and held there by means of a compressed-air-driven turbine wheel. Its speed

is measured by a phototube tachometer that watches a black spot on the rotating system and counts electronically the number of times the spot revolves per minute. The revolving rotor is supported in a rigid frame which is deflected no more than a few millionths of an inch even at the highest unbalance possible. Unbalance forces are transmitted to load-sensitive capsules incorporating quartz-crystal disks and there are translated into piezoelectric voltages. Amplified through suitable electronic circuits, these voltages appear on the screen of a cathode-ray tube as curves telling the location and amount of unbalance in ounce-inches or in the depth of a drilled or milled hole necessary for correction.

Milling cutters or other correction tools can be mounted directly on the balancing platform so that the rotor can be corrected and then rechecked without being removed from the equipment.

Stroboscopic light was useful in the exact balancing of rotating parts in the Norden bomb-sight where tolerances were kept within 20 millionths of an inch. Timed light flashes permitted precise determination of rotating speeds and visual study of unbalance during laboratory tests.

Gas-filled electron tubes called "strobotrons," have been developed recently by Sylvania Electric Products, Inc., for use as sources of stroboscopic light. They can produce up to 240 flashes per second, which is fast enough to give stop-motion effects for continuous visual inspection of moving textiles and printing from high-speed rotary presses, precise timing of cams, shafts, fly-wheels, gears, pulleys, fan

blades, spindles, and shuttles, and many other rotating or reciprocating parts. The tubes also permit visual study of a complete operation by creating stop, reverse, or slow motion which may be photographed for permanent record. The frequency of flashing can be readily controlled and calibrated over wide limits.

ELECTRONIC "WEATHER" — In a technique developed at Wright Field during the war, accelerated weathering is applied to plastics and rubber materials for spot checks on the quality of production, with results being measured by photoelectric equipment. The weatherometer simulates the conditions of rain and sunlight by providing a treatment of two hours of wetting, two hours of irradiation, two more hours of wetting, and 18 hours of irradiation continued through 10 cycles or 240 hours.

The weathering conditions are provided by two infra-red lamps for heat, ultra-violet lamps for irradiation, and a sprinkler for wetting. Three sunlight lamps are used for the ultra-violet source because a flaming arc was found to cause radio interference. The likely changes in the physical condition of the samples after testing are crazing, discoloration, blooming, and warping.

A wire rack is fitted inside the cabinet so that the sample material is centered at a point where water spray, light rays, and an air current from a blower meet.

In the photoelectric weathering equipment, the light source is a six-volt automobile-type bulb mounted in front of a reflector. A Weston Photronic cell with a Viscor filter is connected to a microammeter. A variable resistor is used to adjust the light intensity.

For test samples, strips of cellulose nitrate material 0.125 inch in thickness were subjected to the weatherometer cycle and to outdoor exposure. The amount of discoloration was measured on exposed samples each day by light transmission methods. The test samples were then cleaned of dust and grease and used as calibration standards. The acceleration factor of the instrument was found to be about ten times that of outdoor exposure.

OPERATING RATE — In industrial plants it is often desirable to have a direct indication of the rate at which a punch press, printing press, or other machine is operating. An instrument developed during the war for checking the rate of fire of machine guns can be used without change for applications like these if the action being monitored is in

the range of 600 to 900 movements per minute. The only attachment required on the machine is a simple switch that operates once for each movement to be counted. For higher or lower rates, the circuit can readily be modified and a new meter scale calibration obtained.

Other possible industrial applications include monitoring of life tests and acceptance tests of electromagnetic devices such as relays and solenoid valves.

The rate-of-fire indicator was developed at the San Diego Naval Air Station to fill the need for an instrument which could be used where testing operations require a large number of measurements to be made rapidly. The instrument consists essentially of an electronic counter, an electronic timer, a vacuum-tube voltmeter, and a voltage-regulated power supply.

The mechanical switch unit is clamped to the top cover, directly over the belt-feed slide assembly of a .50-caliber machine gun. The reciprocating action of the slide mechanism actuates a Micro-Switch to initiate generation of a saw-tooth voltage pulse each time a round of ammunition is fired. Firing the gun

thus generates a series of periodic saw-tooth wave forms. These pulses trigger the counter circuit. The timing is controlled by the counter in such a manner as to start and stop the timing action according to the time required to fire 17 rounds. This time interval is thus a direct measure of the rate of fire. A timing capacitor is charged for the exact duration of the counting period, and the resulting potential is measured by a delayed vacuum-tube voltmeter which is calibrated to read in rounds per minute. Any number of rounds between 17 and 32 can be fired but only the first 17 are counted and timed.

Actually, electronic devices have been applied to inspection and testing problems in so many ways that discussion of them all is impossible. However, it should be noted that speed and accuracy are the two outstanding characteristics common to the majority of electronic installations. Whenever a job arises where high speeds or extreme accuracy requirements make manual or mechanical controls unsatisfactory, there is always an excellent possibility of applying electronic equipment.



SKREW CORRECTION

Becomes Automatic When Phototubes Are Used

IN THE textile industry, a beam of light from exciter-lamp and phototube scanning units counts the number of weft threads at each side of a continuously moving web of cloth, compares them to detect skew, and provides impulses by which automatic correction is made. The controls, made by General Electric Company, are used in conjunction with weft-straightening equipment made by Windsor and Jerauld Manufacturing Company.

When weft threads are askew, a light spot at one side of the cloth strip intercepts more threads than does one at the opposite side. For skew in the opposite direction, the opposite situation prevails. The electronic phototubes and their amplifiers are located in cylindrical housings mounted above the moving cloth, where they receive impulses at the frequency of the passing threads. These are equal if the weft is straight, but unequal in case of a skew.

The outputs of the amplifiers are fed to a frequency-sensitive circuit in which a voltage output is produced proportional to the magnitude

and also the direction of the skew. This voltage is used to control the operation of a straightening motor through the action of suitable electron tubes without mechanical contactors being used in the gear.

METAL-TO-GLASS

Seal Produced by Electronic Means

THE METAL contact that makes electrical connection to the coating inside the bulb wall in several types of cathode-ray tubes is sealed into the glass by electronic heating.

The technique consists of placing the bulb on a fixture that holds a small chrome-iron cup against the inside wall. The cup is placed in the field of a one-turn coil supplied with radio-frequency power from an electronic generator and heated until it drops through the glass, leaving a hole. The contact is then placed in the hole and likewise heated until the surrounding glass flows and seals to the metal. Annealing of the glass removes strains set up during the operation.

With the new technique, developed by RCA Victor Division of RCA, the whole process takes about half the time required by the gas-flame method formerly employed.

Amino Acids: In Quantity

Now Produced in Industrial Quantities, Life-Saving Protein Nutritional Elements Provide Medical Science with a New Weapon. Chemical Technology Removes Amino Acids from the Test-Tube Stage by Breaking Down Food Proteins with Acids, Alkalies, or Enzymes

By HOWARD C. E. JOHNSON, Ph.D.

Chemical Editor, Chemical Industries

AMINO ACIDS, rivaling vitamins in their importance to life and health, are the foundation of a new phase of chemical industry. Ever-increasing quantities of these protein "building blocks" are required as scientists unveil the many secrets of the role amino acids play in human nutrition.

Well balanced diets contain all of the amino acids in quantities sufficient for health, but such conditions as severe burns, surgery, starvation, ulcers, and wounds that fail to heal properly may call for excess amino acids in an easily digestible form.

The extent of industrial growth in the production of amino acids is apparent when it is realized that ten years ago no amino acids were produced commercially, within the last few months, tons of the life-giving substances were flown to Europe to help restore the health of the half-

starved inhabitants of war-devastated countries. Just as sulfa drugs, vitamins, and penicillin have outgrown their test tubes, so have amino acids progressed far beyond the laboratory stage.

Proteins are combinations of several of the 23 naturally occurring amino acids joined together by chemical linkages. Often proteins contain other components such as fat molecules, sugar residues, or phosphorous compounds in addition to amino acids. The arrangement of all of these elements is so complex that no natural protein has ever been duplicated by synthesis.

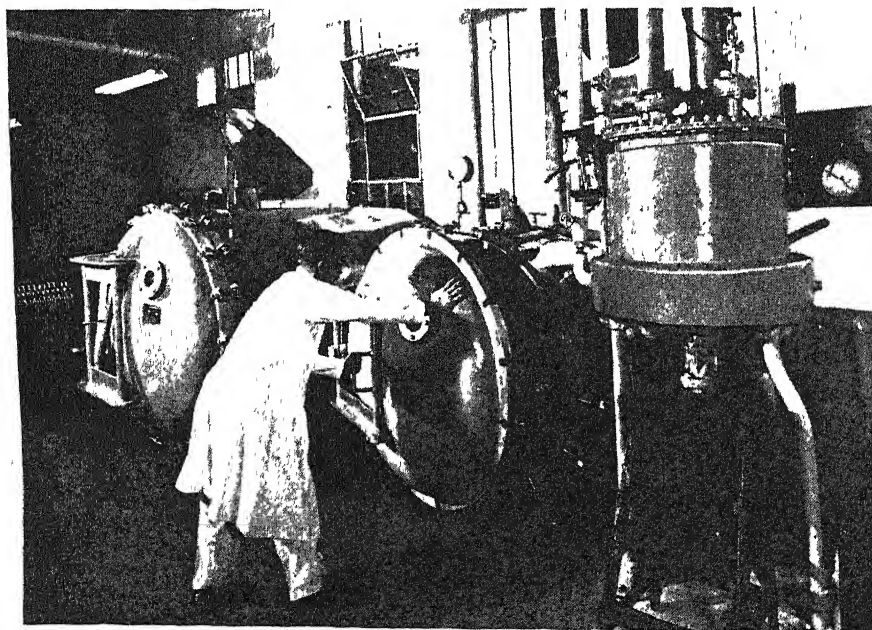
The functions of the proteins themselves have been generally appreciated for years, but it is only within the past decade—since Rose's discovery of threonine, one of the essential amino acids, in 1935—that any significant progress has been

made in understanding their specific nature. Since the complex protein structures did not lend themselves easily to study, it was necessary to examine the individual "bricks" or amino acids of which they were made. As has been said, proteins themselves cannot be synthesized, but the simpler amino acids can be, and, indeed, many of them are now commercially available. Nutritional studies with the pure individual acids have led to the conclusion that at least 8 of the 23 are essential to human life.

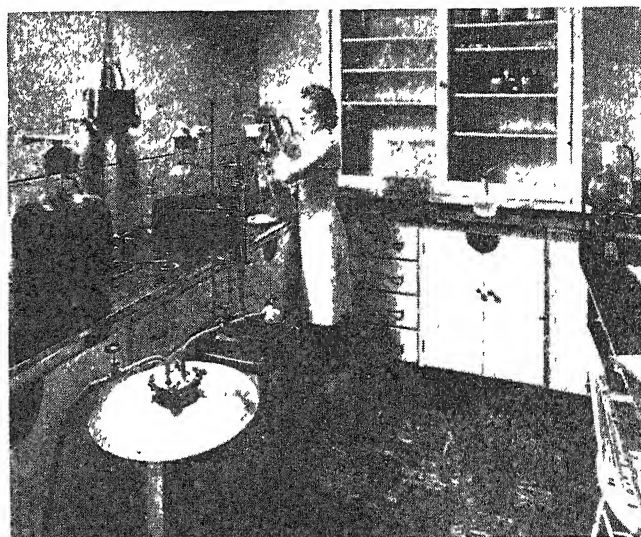
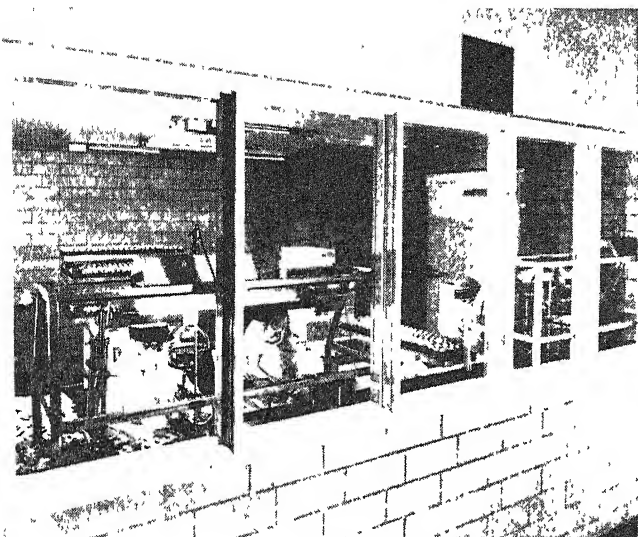
PRODUCTION—For some medical uses a mixture of the pure synthetic amino acids in a suitable medium would be ideal. Even if enough of the essential acids were available, however—which is not the case—only a millionaire could afford such a remedy, since some of them cost as much as 400 dollars a pound. Synthetic amino acids are used for fundamental research, but it is not practicable, even if it were possible, to provide them for general medicinal use.

But it is possible to prepare a fairly pure mixture simply by breaking down a natural protein such as casein, the protein in milk, which contains all of the necessary acids, into its components. When correctly prepared, such a mixture is suitable for any of the various means of administering it to the patient and is equivalent in nutritional value to a pure synthetic mixture. Moreover, it can be prepared for a small fraction of the cost of the synthetic amino acids.

During the early development of these products, proteins of liver, blood, milk, horn, hair, and several others were investigated as possible sources of amino acids. Today, read-



Amino acids must be sterile; steam autoclaves sterilize equipment and containers



Photographs courtesy Frederick Stearns & Company, Division Sterling Drug, Inc

ily obtainable milk protein, purer than most natural proteins, and containing all the essential acids, is generally used.

Proteins can be broken down by acids, alkalis, or by enzymes. Each of these methods has inherent advantages and disadvantages, and at least two—acid and enzymatic—are used by the 25 or more manufacturers who have entered the field.

The main disadvantage of using acids to break down the protein is that one of the essential amino acids, tryptophane, is completely destroyed. Pure tryptophane is stable insofar as the acid is concerned, but certain other chemicals present in natural proteins cause it to solidify and form a resin. Consequently, synthetic tryptophane must be added to the amino acid preparations, if they are made by the acid method, in order to make them complete. The advantages of the acid method are thought by some manufacturers to outweigh this disadvantage since the final amino acids are purer, the acid used for the protein breakdown is, for all intents and purposes, completely removed; micro-organisms and fever-producing substances are destroyed, giving a safer final product; and the method is simple.

Alkaline protein breakdown does not destroy tryptophane, but some of the amino acids are altered in their chemical configurations in a manner that is tantamount to destroying half of them.

Protein breakdown by enzymes (catalysts produced by living cells) retains the amino acids in their natural form, but the final product contains a good deal more than amino acids. Undigested or only partially digested proteins, decomposition products of the enzymes or, proteins, and non-protein fragments of the original material may be present. Thorough purification

Constant tests (above right), packaging in sterile rooms (above left), and rabbit reaction trials (right) ensure final quality of amino acids



is absolutely necessary, then, for while amino acids are perfectly compatible with blood proteins, foreign proteins in the blood lead to serious complications. Micro-organisms, moreover, are not destroyed by enzymatic digestion, and the fever-producing substances cannot be readily removed from the final product.

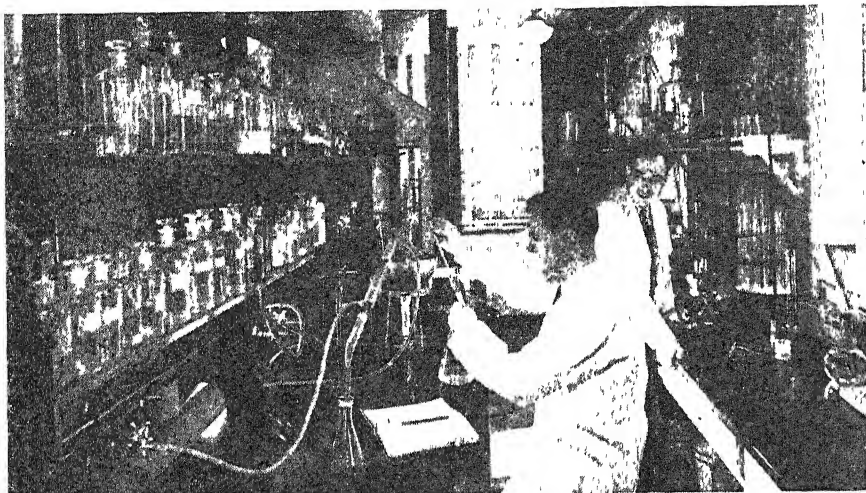
ACID METHOD—In the preparation of one commercial product, milk protein is treated with 20 percent sulfuric acid at a temperature of 120 degrees, Centigrade, for 16 hours. This treatment effectively breaks down all the proteins into their component amino acids, although the tryptophane is destroyed. The sulfuric acid is removed for the most part by slaked lime, the calcium sulfate being removed by filtration. The filtered material is then placed in a still to concentrate it and at the same time remove free ammonia, and the ammonia-free product is then saturated with carbon dioxide, using dry ice, to remove excess calcium as calcium carbonate. The remaining calcium is removed, after filtration of the calcium carbonate, by the addition of oxalic acid to form the highly in-

soluble calcium oxalate. A very small amount of calcium, to the extent of 10 to 20 milligrams per 100 milliliters of solution, is allowed to remain in order to avoid the presence of oxalic acid. The calcium oxalate is filtered off, and a barium salt is added to remove the last traces of sulfate.

When this process is completed, all that remains to be done is to adjust the concentration of the solution to 15 percent amino acids and to add tryptophane to the extent of 1 percent of the total amino acid content. The final amino acid solution is passed through a filter and packaged.

STERILITY—It goes without saying that any product intended for human medical use must be absolutely free of any disease-producing organisms.

In order to render the amino acids perfectly sterile, they are passed through a porous porcelain filter, the passages of which are so fine that all bacteria or other micro-organisms are held back. This is done in a sterile room equipped with ultra-violet lamps. Not less than ten bottles from each batch of 1000 bottles are taken at random by inspectors and sent to a bacteriological



Biochemists, in research laboratories like this one, synthesized amino acids, but larger quantities are produced by chemical breakdown of natural proteins

control laboratory for sterility testing according to standard medical methods. If one or two bottles do not meet the test, ten more bottles are similarly tested. If sub-standard results are obtained on any of these, the whole lot is rejected.

In addition to sterility testing, each lot is tested on rabbits for fever-producing substances. Finally, samples of each lot are sent to a hospital for testing on man. Only when all these tests are passed satisfactorily is the lot pronounced acceptable.

OTHER METHODS—After weighing the relative merits and drawbacks of the three types of amino acid manufacture discussed here, some manufacturers have chosen the acid method. Another large manufacturer has modified the procedure in such a way that not all of the tryptophane is destroyed; about half of it is lost, but the remainder is

available for nutritional requirements. Still another manufacturer uses the enzymatic method with success.

A different type of purification, still in the development stage, employs the so-called ion-exchange resins. Here the protein solution is passed through a special type of synthetic resin. The amino acids are selectively adsorbed by the resin and the impurities pass along and are discarded. The acids are then simply dissolved off the surface of the resin, giving a solution of pure amino acids.

The experience of the last few years, particularly with respect to wounds and malnutrition resulting from the war, has demonstrated conclusively that amino acid preparations can save lives given up for lost; and increasing knowledge of their power will undoubtedly expedite their use as standard equipment to combat death and disease.

MOTOR FUEL

Possibilities Found by Russians in Turpentine

TURPENTINE is the raw material for "Uratol," a new aviation gasoline anti-knock compound developed in the Ural division of the Russian Academy of Sciences and said to be twice as effective as iso-octane.

It is also stated in the Russian literature that turpentine is being employed to some extent as a regular motor fuel for trucks, tractors, and other motorized equipment used in the lumber industry, although at present its principal function in this role appears to be starting engines which operate on producer gas.

The use of turpentine as a motor fuel, one authority states, is attended with difficulties—particularly acid-

ity and gum formation; and larger carburetor jets are necessary because turpentine is more viscous than gasoline. The fuel-air mixture, moreover, must be preheated to 140 degrees, Fahrenheit. Another author contends, however, that Soviet-made tractor engines designed for gasoline require no change to burn turpentine.

The study of turpentine utilization as a motor fuel is still in progress, and such processes as cracking are being investigated.

DURABLE BAGS

Proved by Trip Over Niagara Falls

WAR-TIME developments in high wet strength imparted to paper by resins were given dramatic proof in

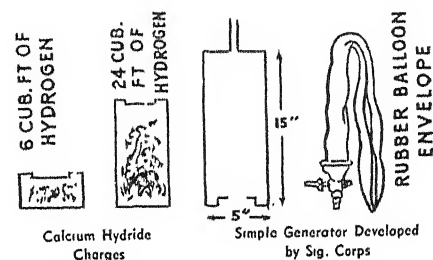
recent test in which the new paper bags were dumped into the Niagara River and later recovered intact after dropping over the Falls. The bags were heavy-duty, multi-wall shipping containers and they were loaded with 50 pounds of flour each. After seven and a half hours' immersion and the hazards of passing through the rapids, the Falls, and the Whirlpool, the bags were still intact and the flour in perfect condition.

"CANNED HYDROGEN"

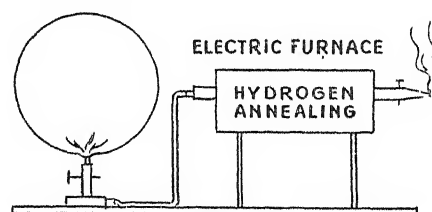
*Can be Stored Indefinitely,
Used When Needed*

LARGE quantities of hydrogen were needed during the war for inflating meteorological balloons, but it often was not feasible to transport heavy cylinders of the gas through jungles or over rough terrain. To meet this need, "canned hydrogen" was developed in the form of canisters of calcium hydride, which reacts with water to produce the hydrogen gas.

Various sized tins of the grayish-white material will deliver from 6 to

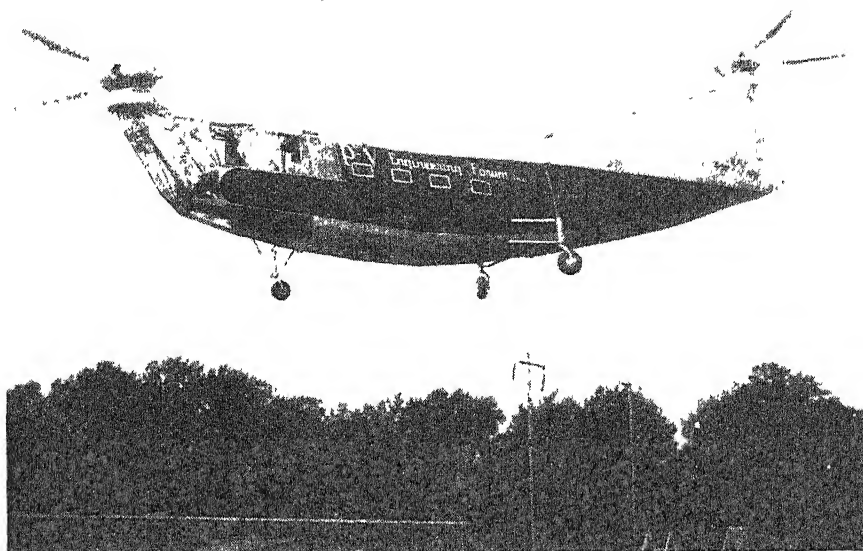


Above: Two sizes of "canned hydrogen" containers and the generator.
Below: One industrial use of the gas



24 cubic feet of the gas simply by punching holes in the container, submerging it in water, and collecting the hydrogen in a rubber balloon which acts as a simple gasometer. The unopened tins may be preserved indefinitely.

Tons of the hydride were made for military use, and now it is available to all who need a convenient source of hydrogen gas that can be kept on stockroom shelves. The chemical can also be obtained in bulk for use in acetylene generators to produce hydrogen. Here, the calcium hydride is used to produce hydrogen exactly as carbide would be to generate acetylene.



Progressive helicopter designs, such as the PV-2—10 passengers and 110 miles per hour—bring fast local service and short inter-city air hauls nearer reality

Helicopters in Civil Aviation

Will the Helicopter Find Immediate Application in Civil Aviation and Industry; or Will Engineering Limitations, Landing Area Problems, and the High Degree of Pilot Skill Required Restrict its Utility? Present Indications Point to Wide Operational Fields When Problems are Solved

By ALEXANDER KLEMIN

Aeronautical Consultant Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

INTEREST in the helicopter is general, but the American public is particularly anxious to know how soon, and in what manner, the versatile helicopter will be put into service in civil aviation. These questions are difficult to answer—yet a broad survey of the helicopter's characteristics and its applications should provide a reasonable estimate of the immediate future of rotary-wing aircraft.

Although the helicopter's performance is improving more rapidly than did the performance of early airplanes, Igor Sikorsky, the eminent rotary-wing aircraft designer, advises that it is likely to remain a short range, slow speed, craft that will never compete with the airplane in speed or load carrying capacity.

But vertical flight, the helicopter's special characteristic, is so attractive that even its present low speed and small load capacity can be discounted in some applications. There are, however, other limitations to commercial helicopter operation.

LIMITATIONS—Dynamic and static stability, normally present in commercial airplanes, are not normal characteristics of a helicopter and the pilot, who must constantly be on the alert, enjoys neither a feeling of security nor physical or mental relaxation. To facilitate hovering and landing, the fore-part of the cockpit is usually equipped with a large transparent area to allow complete vision. But this very completeness of vision tends to create a sen-

sation of vertigo which, associated with an apparent lack of structural protection, again increases the sense of insecurity. Control stick shaking is prevalent in many types of helicopters, and vibration, both on the ground and in high speed flight, has not quite been eliminated. Instrument location, rather unsatisfactorily adapted from airplane practice, is apt to interfere with the pilot's vision or impose a strain on his eyes.

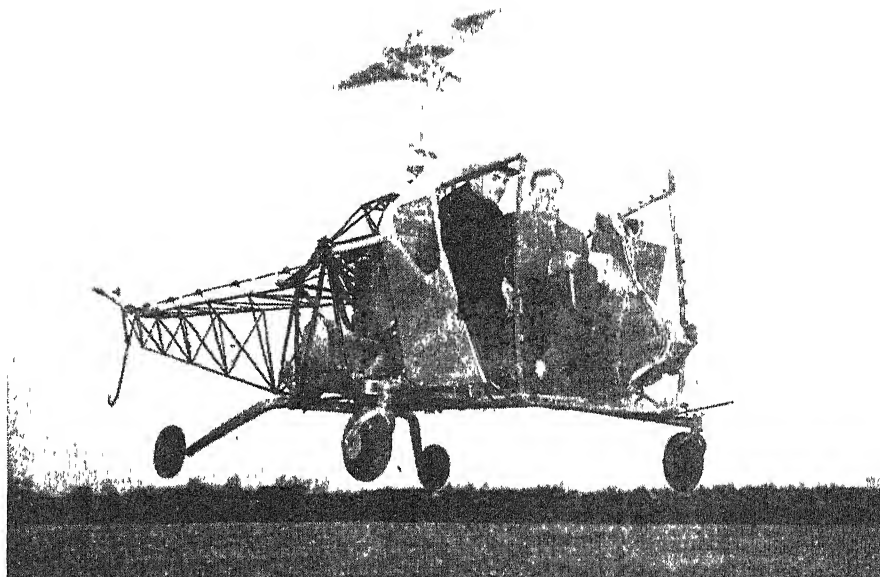
The conventional airplane's three surface controls (elevator, rudder, and ailerons) and the throttle, contrast with the helicopter's similar controls plus a pitch change lever. Pushing the stick forward and opening the throttle, from a hovering condition, does not give level forward flight, as it would in a conventional airplane, but instead, causes the helicopter to climb. Only by lowering the pitch control level can forward speed without climb be obtained, and this involves a difficult problem in control coordination for the pilot. When a tail rotor is employed to offset main rotor torque, more power, and hence more torque, imparted to the main rotor means

that more balancing force is required from the tail rotor. Here again, there is an immediate problem in control coordination.

While one of the prime advantages of the helicopter is its ability to rise and descend vertically, the rate of descent with power off is so high that damage, if not injury, is likely in a truly vertical power-off landing. However, experienced helicopter pilots explain that power-off landings need not be straight down since the helicopter can descend along a slanted glide-like path in a manner similar to an autogiro. Just before landing, the machine can be "flared" or forced into a nose-high attitude so that for an instant it will be reconverted into a helicopter with the inertia of the rotor blades substituting for engine power. This extra lift cushions the landing. But regardless of such special techniques, these limitations do make the helicopter more difficult to operate, even though safer, than the airplane. Its use in transport work would require highly skilled pilots and it is doubtful whether it has yet reached a stage where free utilization by the general public is feasible.

PROGRESS — Limitations notwithstanding, the helicopter in principle should be the easiest of all aircraft to fly. Low visibility—and other weather restrictions that ground airplanes—apply in less force to the helicopter. The safety inherent in the ability to use small landing areas and the convenience of mid-air stops and hovering should, with technical progress, make the helicopter easier to fly and adaptable to a wide range of purposes.

Improved landing gears with unusually long shock travels are promised to make vertical landings safer, while designers report that the cockpit will be improved with a line of visual reference to eliminate the vertigo. Structural strength at the nose of the cockpit will be made available without loss of vision. Throttle and pitch lever will be suitably synchronized so that the pilot will have one less control to think of, or, more likely, a governor will take care of the pitch while the pilot will control the throttle manually. The stabilizing tail rotor, with its attendant difficulties, may be supplanted by other rotor configurations such as the tandem, the side by side, or the coaxial type. With the latter, two rotors, one above the other, turn on a single shaft, thus avoiding the asymmetrical forces of the tail rotor. Helicopter stability in forward flight will be improved by suitable aerodynamic design and, in hovering or vertical ascent, by the



Inherently versatile, helicopters may be ideal for police work, forest patrol, and like jobs. Governor Dewey, riding in an experimental Bell craft, symbolizes official interest

use of either an inertia stabilizer, of the type already used successfully on the Bell helicopter, or an automatic-pilot type stabilizer with a gyroscopic indicator similar to that used in the airplane.

Difficulties in learning to fly a helicopter may exist for the airplane pilot who is apt to treat the "whirligig" with contempt and is impatient of learning a new technique. But a reasonably well coordinated man who is not an airplane pilot should be able to fly a helicopter after just a few hours training.

COMMERCIAL USE — Experienced rotary-wing aircraft men have recently recommended to the Civil Aeronautics Administration that helicopters be permitted to fly at low altitudes, under conditions of poor visibility, and that navigation by "natural guides" such as railroads, highways, rivers, and so on, should be allowed. Thus there is every indication that the helicopter will fear fog, darkness, gusts, and snow, much less than other aircraft and will continue to operate when all other aircraft are grounded.

Moreover, applications to the Civil Aeronautics Administration for operations between cities that are not far apart, and from the centers of cities to local airports, have been numerous, and eventually such craft as the PV-2 helicopter, built by the PV Engineering Forum, will make these operations practical. The PV-2, a tandem machine with a one man crew and a ten passenger capacity, has one rotor placed far behind and above the other. This disposition of rotors gives ample room for the passengers and reduces aerodynamic

interference due to downwash, since the rear rotor is above the front rotor. Because the passengers are located at the center of gravity, the PV-2 helicopter can fly lightly or heavily loaded without the trim or balance being overly disturbed. The cruising speed of such a craft, when powered with a 450-horsepower engine, is estimated at 110 miles per hour. The maximum vertical rate of climb is 700 feet a minute with a maximum rate of climb on an inclined path of 1000 feet per minute. It is a curious fact, supported by all aerodynamic theories, that a helicopter will climb faster on an inclined path than when going straight up.

Mr. Frank Piasecki, President of the PV Engineering Forum, and Harry Pack, computed the cost of a typical operation between the heart of New York City and the airport at Idlewild as 5.19 cents per seat mile. A twelve minute trip to Idlewild, with all due allowances, would cost \$1.75 per passenger—somewhat higher than the fare charged by an airport limousine or bus, but one which would be entirely reasonable in view of the comfort and speed that could be offered.

There is one difficulty which has to be faced: where in the heart of most cities could a helicopter airport or terminal be located? Artist's conceptions of roof-top helicopter airports are found in many publications, and such airports are quite possible in the sense that there will be no structural difficulties in taking up landing shocks on the roof or in providing ramps, elevators, administrative offices, and parking space for the rotary-wing machines

themselves. But experienced pilots foresee other problems in the gusts created by the man-made canyons of large cities, and they dread the hazards to the machine itself and to the occupants of adjoining office buildings. It has been suggested that roof-top landings be made on platforms built over two adjacent piers or like structures when the relatively undisturbed surroundings of a waterfront are available to a city.

There are some interesting studies yet to be made in the design of roof-top airports: studies in aerodynamics, in the streamlining of the terminal itself, and perhaps in the streamlining of the adjoining buildings!

OTHER USES—But if there is some uncertainty regarding roof-top terminals and short-haul transportation, there seems to be no uncertainty regarding the immediate employment of the helicopter in other industrial and commercial applications. Although the helicopter will be burdened with the cost of transmission, clutch, over-riding devices, and so on—a four- or five-place machine will cost \$25,000 rather than \$5000—for certain uses these costs will be secondary, provided the results can be achieved. During the war helicopters flew 30,000 hours on all kinds of missions, principally in ambulance and rescue work, and similar peace-time uses are highly probable. Mr. Sikorsky, reporting the use of the helicopter as an instrument of pest control, says: "Insecticide released under the helicopter rotor disk is driven downwards among foliage which is so agitated that the undersides of the leaves, the stems, and the stalks can be reached by the chemical."

Governor Thomas A. Dewey, who recently made a flight in a Bell Aircraft machine, said that the machine would be most useful in rescue work by the state police and in fighting forest fires. Helicopter builders suggest that the "whirligigs" may also be used for crop dusting, pipe line patrol, suburban ambulance service, department store rural deliveries, geological surveys, mining work where the terrain makes access difficult, and in the laying of wires and cable.

FUTURE—Predictions of the helicopter's immediate future are difficult, but the following points seem fairly well established:

1. The opportunities for industrial application of the helicopter have been partially explored. By the end of 1946 or early in 1947, when one or two manufacturers have secured certificates from the CAA, taken out

some of the "bugs" that still remain, and achieved some degree of production, they will be filling orders for machines for industrial purposes.

2. An excellent market is indicated for short-haul work. In the hands of well trained personnel, with adequate capital, such operations should be economically feasible and probably more immune to weather than airplane operation. The problem of city landings remains to be attacked in a serious spirit.

3. It will take more time for the helicopter to become a family or private flying machine. High prices and certain difficulties in operations must disappear before the predictions of optimistic writers can be fulfilled. Yet, eventually, the helicopter should be unexcelled for private flying.



FASTEST TRANSPORT

*Will Cruise at Over
400 Miles an Hour*

BUILDER of the P-47 Thunderbolts, Republic Aviation Corporation claims that their new transport model, the Rainbow RC-2, will be the world's fastest transport airplane. The top speed will be 450 miles an hour, and guaranteed cruising speed will be over 400 at an altitude of 40,000 feet. There are a number of factors which allow the designers of the Rainbow to give this guarantee with confidence. First there is the tremendous power—four engines of 3250 horsepower each, giving a total of 13,000 horsepower for a gross weight of 113,250 pounds. This is a horsepower loading of only 8.75 pounds per horsepower. Another factor is the utilization

of the thrust-producing power of the exhaust. No longer is the exhaust of the engines shot out into the atmosphere as just so much useless burned gas. It is claimed that the utilization of the jet adds 200 horsepower to the effectiveness of each engine.

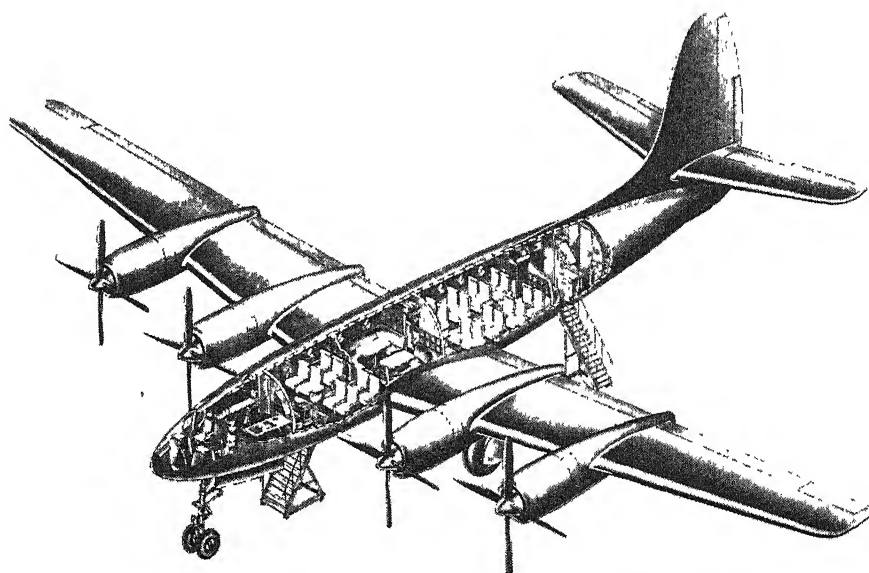
It will be noted that there is concentration of purpose on carrying a relatively small number of passengers and little cargo at top speed and in luxury. Modern styling, pressurized and noise-proof cabin, complete dining facilities, lounge, ample bar, plane-to-shore telephone, motion pictures, and so on are to be part of the appointments.

FLYING WIND-TUNNEL

*Tests Wing Designs
Under Flight Conditions*

ALTHOUGH the wind-tunnel has played a vital part in aviation research and will continue to do so, wind-tunnels cannot do all the experimental work since some tests are best made under actual flight conditions. Therefore, Lockheed Aircraft has converted one of its P-38's, the Lightning Swordfish, into the world's fastest flying wind-tunnel to be used for testing the wings of fighters and transports in the 500-mile-an-hour speed range.

Envelopes, or false wings, are mounted over the permanent wing structure. A series of static tubes arranged behind each envelope, and pressure distribution holes in the envelope surface, connect, respectively, with drag and lift measuring instruments in the cockpit. Various blower and suction slots in the false wing are employed to investigate boundary layer control problems. All test instrument readings are recorded by an automatic camera.



Propellers work in conjunction with jets at rear of engine nacelles

Never-Ending Studies

Time and Motion—All-Important Factors in Industrial Processes—Have Been Studied for Years and Will Have to be the Subject of Eternally Continuing Studies. Every New Industrial Change Must be Geared to the Ever-Present but Never-Changing Human Being

By EDWIN LAIRD CADY

JUST a few weeks ago, the methods engineer of an electrical products manufacturing company finished the six months observation period during which he had measured the results of his time and motion study in the assembly department, and found that labor costs per assembly had gone down 50 percent while output per man hour had gone up 100 percent. The superintendent of a continuous pouring foundry had just told his management board that an accident record which looked black when a new process was installed a year ago has been reduced to the vanishing point by time and motion studies.

Statements similar to those two could have been made as well in 1896 as in 1946 and will still be made in 1996. Yet, strangely enough, these studies which keep on changing industrial pictures are based on the one thing in industry which does not change: the speed with which human eyes can see with certainty

and human muscles can work with comfort and safety.

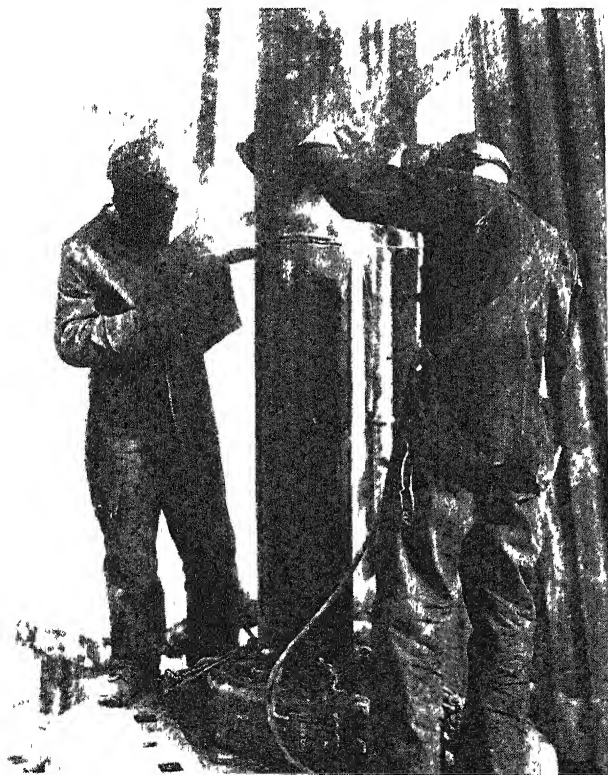
Men who make these studies with the greatest success are experts in human nature first and in mechanical processes second. They are great teachers but greater co-operators.

In an electrical products assembly department it took weeks of painstaking observation to find where any improvements at all could be made. Hourly records showed that production fell off during the closing hours of shifts, and this only could mean worker fatigue. But the exact factors causing that fatigue had to be isolated.

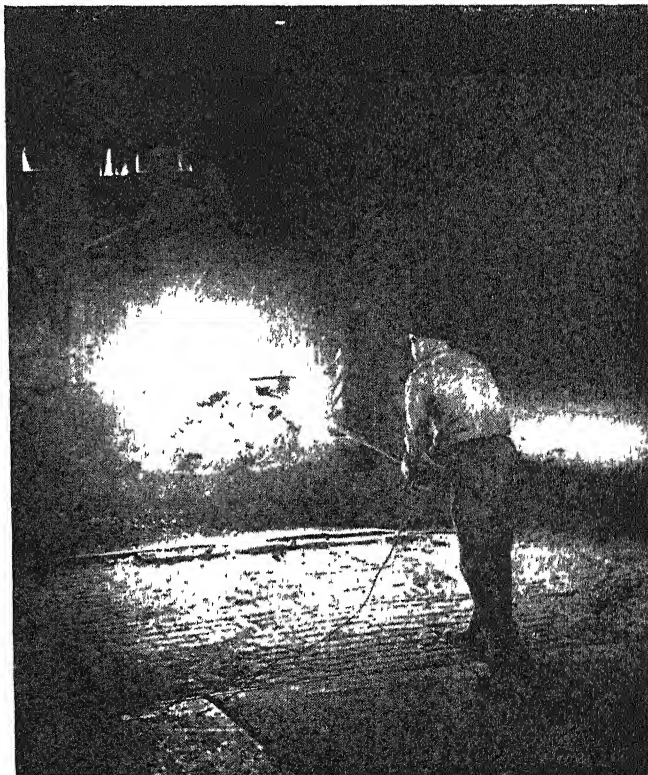
Analysis of the work spoiled in those "end of shift" hours was made

first. The first effects of tiredness, of taking a physical beating, are almost always found in those operations which require slightly unnatural motions of the muscles or eyes. When the methods engineer knows what motions are causing spoiled work he also knows the primary sources of fatigue.

The fitting of a split ferrule onto a glass tube and the bolting of this to a reflector was causing the most breakage. The answer was that the right hand of the operator became fatigued from handling the powered bolt and nut setter, and the left hand from holding the assembly in place. A change was made so the operator did five assemblies right-handed,



Two men working on one weld must have their operations timed so they can work efficiently without mutual interference



When a pyrometer is thrust into molten steel at 3300 degrees, Fahrenheit, handling and timing by the operator must be exact



A precision instrument can be slow or rapid to operate, the optimum speed is determined by means of a series of time and motion studies

then three left-handed, and kept up this alternation. The procedure slowed down production in the early hours but raised the all day performance. And, of course, other spoilage-causing operations were tracked down until the overall speed was up but the fatigue was low

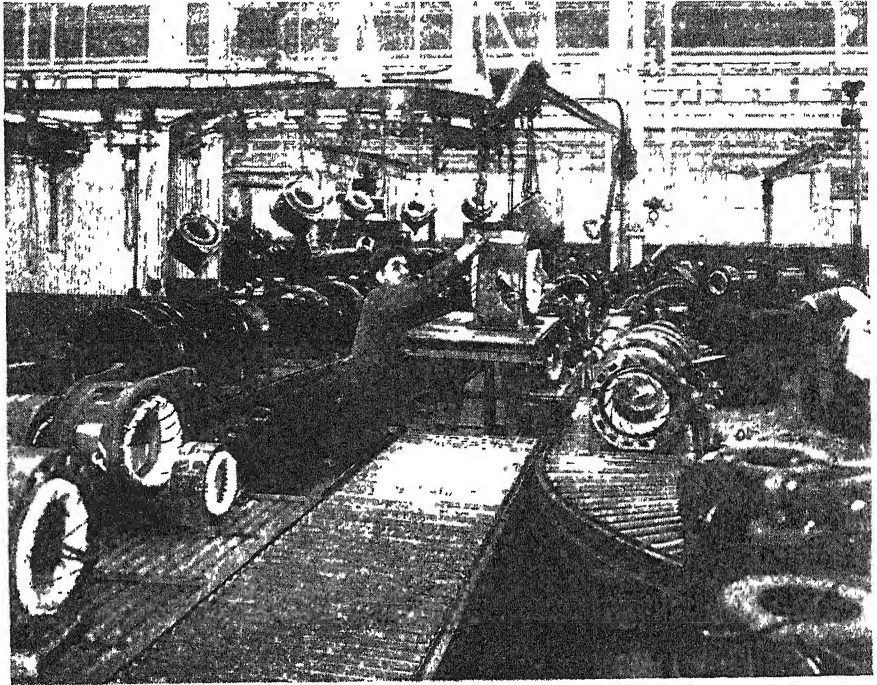
In the foundry, observation showed that tired men had a tendency to carry the bowls of their ladles behind them instead of keeping them in sight. The cue was to teach the men how to hold the hot ladle handles for better balance and use a handling method that would

put the weight on their legs and rest their backs. This reduced the accidents; it also raised production.

Every change in machinery, every new safety device, every new product, means new time and motion studies. Better equipment means that mechanical motions will perform operations with speeds that human hands and eyes cannot attain; safety devices remove inhibi-

tions and let men reach speeds that they had not previously dared; new products need new work habits. Time and motion studies cause factories to install better lighting, better conveyors, better air-conditioning. To every industrial change must be geared the human body, which does not change, but that changeless human element is the greatest cause of industrial change.

Every new materials-handling system requires new time and motion studies. Such studies often result in new systems and the cycle continues to improve production
Westinghouse photograph



LIGHT-WEIGHT CONTEST

*Scheduled for Materials
Suppliers in Textile Field*

SHIPPING of "warps" from factories which make rayon threads and yarns to mills which weave fabrics is in its "just beginning" or "infancy" stage right now, but it is growing rapidly. And it is presenting a new field to makers of lightweight metals, woods, and other materials, a new arena for battles among the materials which are sold on the strength-for-weight basis.

The warp is made up of the lengthwise or "strength" threads of a fabric, the crosswise threads (which are woven into the fabric by the shuttles) being known as the "wool" or the filler. All the warp threads for a single loading of a loom are wound side by side on a mandrel which is called the beam. Light weight is essential to the beam since heavy weight means inertia and inertia can cause breaking of threads. Therefore the supplying of materials of which the warping beams are to be made is a

competitive field among makers of magnesium, aluminum, stainless steel, hydrolized or laminated woods, plastics, and glass.

When the warps are shipped from plant to plant they must be wound on beams to hold the threads in place. Sometimes these beams are warping beams which will fit the machinery in the receiving plant, and sometimes they are special shipping beams from which the warp will be removed before installation in the loom, the shipping beams then being returned to the thread manufacturing company. Warping beams also may be returned.

A single truck load may contain dozens of warps. Therefore the weights of the beams are highly important in shipping costs.

The beams also must be able to stand the handling methods which truck loaders are apt to use, and the shocks and stresses of transportation. This calls for care in structural design as well as in the selection of materials which can withstand abuse.

Structural strength problems can

be still greater in patented beams which are made demountable or in separable parts to solve problems of transferring warps from shipping to warping beams and to reduce the shipping space needed for return trips.

In addition to meeting such requirements the beam materials must be corrosion resistant to the extremely high humidities which are maintained in textile mills and to the chemicals which are found in some threads.

Cotton warps also are being shipped. Altogether, this market promises to be highly interesting to the makers of the materials which are most likely to compete for it.

FIRE PROTECTION

*Needs Careful Study by
Communities and Industry*

FIRE DEPARTMENTS are marking fire hydrants with color and other codes to show how many gallons of water per minute can be pumped from each hydrant at full flow. Hydrants rated at less than 500 gallons per

minute receive one marking, 500 to 1000 a second, and 1000 or over, a third.

Many an industrial plant which depends upon the local fire department for protection may find that the growth of its community has exceeded that of the water supply and that there would be insufficient water supply at the nearby hydrants if the factory were to suffer a serious fire. This is especially true in towns which expanded greatly during the war.

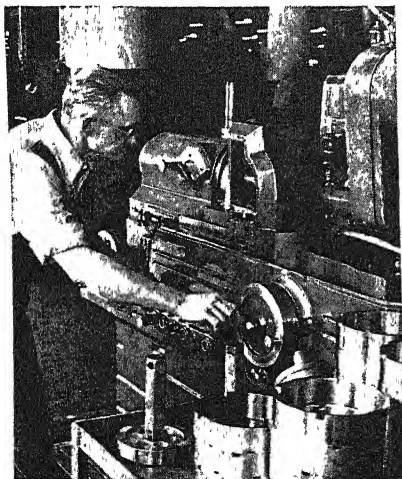
The answers of fire departments to these situations are: more careful studies of water supplies and pressures, use of pumpers rather than depending upon hydrant pressures, and, in some cases, requiring the factories themselves to erect more adequate water tanks or to equip their premises with ponds.

MACHINING SPEEDS

Increasing Rapidly as New Techniques are Developed

ARRANGING a thread-grinding machine so that the diamond dressers automatically true up the wheel at predetermined cycles, then stepping up the spindle speed to 15,000 revolutions per minute has enabled the DeSoto Division of the Chrysler Corporation to cut in 8 minutes threads which formerly required 32 minutes.

This is only one example of what is going on in the redesigning of machine tools to take advantage of high spindle speed possibilities. Just now, this field is having the same kind of growing pains that bothered the automatic screw machine field in 1920 and the tungsten carbide field in 1930. Single problems keep recurring in all new applications; the problem most common to high machine speeds being that the operator does not have time to observe and correct tool wear before the



Automatic wheel dressing has stepped up the speed of this thread grinder

work is spoiled. Consequently these functions must be accomplished by automatic mechanisms built into the machine.

When a few more techniques of automatic control have been worked out, speeds will go much higher. Thus, in the foreseeable future machines of the kind shown here will work at more than 100,000 revolutions per minute.

FINE THREADS

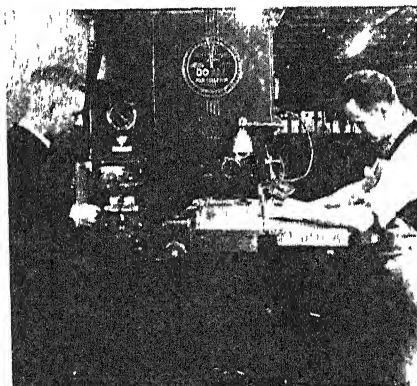
Now Produced By Stamping

STAMPING has now joined cutting, rolling, and extruding as a method for producing fine threads to precision tolerances.

SET-UP WELDING

Handles Difficult Machining Problems

THE CASUAL way in which accurate electrical welding can be handled today is illustrated by the rejoining by welding of saws after they have been separated for inside contour



A saw-welding mechanism is mounted as part of this production band saw

sawing; this rejoining being done by self-contained welding mechanisms which are mounted as parts of the sawing machines.

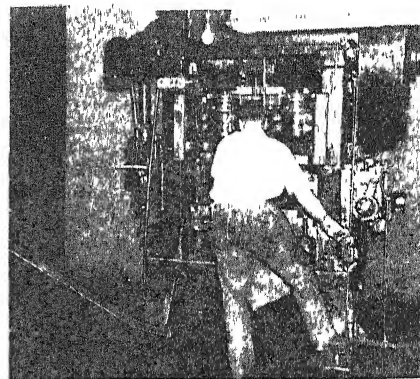
There are many other tool and guide parts which must be set up on machine tools under circumstances which make it difficult to use bolts, screws, clamps, magnetic plates, or any other of the more common set-up devices. Use of welding to handle such problems is quite new at the present but will become familiar within the next few years.

EJECTION MECHANISMS

Aid in Eliminating Production Troubles

PROBLEMS of materials handling and even of product assembling are being solved by better machine tool ejection mechanisms.

In the example of a high speed automatic Bliss press in the plant



Correctly stacked armature laminations are delivered by tube at left

of the Owen Dyneto Corporation, armature laminations are turned out at the comparatively high rate of 220 per minute and yet they come out of the ejection tube shown at the left of the picture correctly stacked.

FASTER HEATING

Possible When Thermostats Are Adequate

WHEN thermostats are quick acting and adequate, more electricity can be fed to heating elements, larger gas flames can be used, heat sources of higher Btu capabilities can be employed. The higher capability heat sources heat up the work more rapidly, bring it to working temperature more quickly, restore temperatures as Btu's are lost to the work faster. The heat balance is one of more heat units available to the work, kept in check by quick acting and durable thermostats.

Soldering irons are using this principle. They reach working temperature in 90 seconds after being plugged in, maintain the temperature needed by the kinds of metals being soldered and by the structural shapes of the work and by the types of solder, and they do not over-heat.

ZINC COATS

Protect Wire, Solder Better Than Tin

METALS coated with copper or with tin for easy soldering are an old story. During the war the supply of tin became short and threatens to remain short for the first several years of peace. The problem, then, was to find a tin substitute.

Wire makers turned to alloys of zinc. And zinc coatings for wire have been developed to the point where they have two to three times the rust resistance of the old tin coatings, are excellent lubricants, and even stand up well in severe acid or gas fumes. They solder better than the tin.

The Public And The Engineer

Realism, Not Ivory-Tower Gadgetry, Keynotes the Thinking of Successful Automotive Designers. Economic Trends, Production Problems, and Public Tastes Sometimes Outweigh Engineering Considerations; While Research In Apparently Unrelated Fields Answers Baffling Questions

By LESLIE PEAT

WHenever a group of automotive engineers gets together in discussion of the car of the future, you can count on several realistic suggestions that the broader phases of the industry's economics and other non-engineering factors may be more important than technical design considerations. The day of rugged isolationism in engineering is about done for, despite considerable current pressure supporting the philosophy of specialization.

The meshing of the industrial gears required to produce automobiles, trucks, and buses in this country is something wonderful to behold. One of the larger corpora-

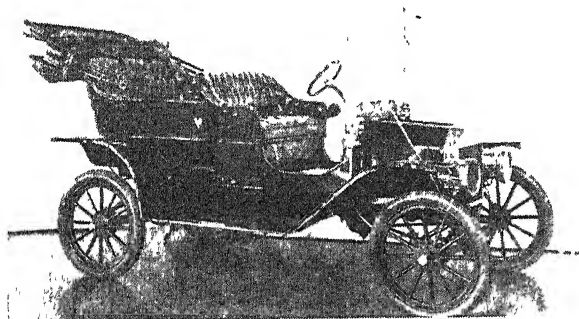
tion at least, that he must keep up with mass-production manufacturing developments if he is to succeed as an engineer. And he is riding for a hard fall unless he also keeps up with competitive developments and knows in a general way what is being done in at least some fields of heretofore unrelated research.

Inventors of gadgets, revolutionary powerplants, and vehicles alike feel that they have no time for "extraneous" mental activity. The automotive engineer, if he is a man of experience, tempers his hopes for his brain child with an understanding of the complex mecha-

nism of the end product, and frequently he will further temper his aspirations with some consideration of public acceptance, ease of repair and maintenance, and check his design with production engineers with a view to modifications that will permit ease of manufacture.

More and more vehicle engineers are learning more and more about fleet operation, yet important spokesmen of the automotive engineering fraternity openly declare that the designer knows too little about the use to which his product is going to be put. In the early days it was relatively easy to keep track of customers' complaints, and to get a measure of prospective customers' needs. Buyer and designer would sit down together and work out the design to the satisfaction of the former, and with some degree of certainty that the latter could and would produce it. The late Alexander Winton used to tell of some of these sessions in the early days of his career, and he recounted with gusto the sound ideas that he got in that manner.

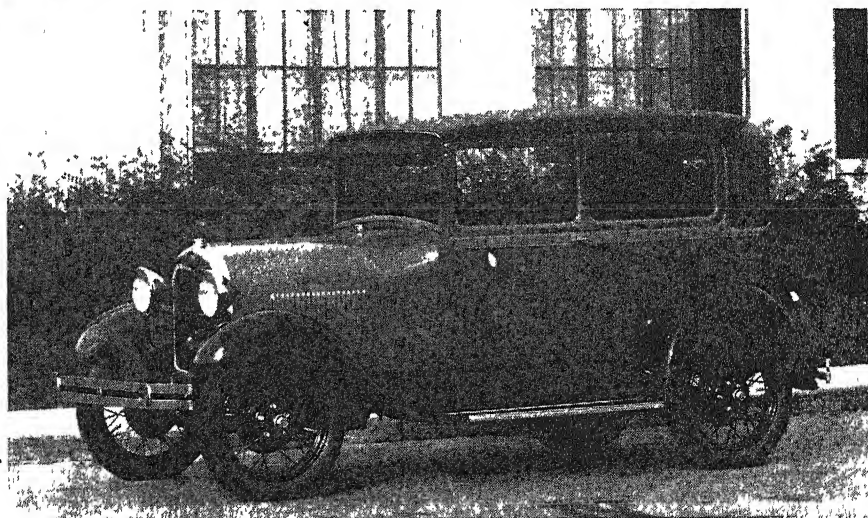
Obviously, customer research and



Separated by 21 years of automotive progress, the Model "T" Ford (left) and the Model "A" (below) show how public's tastes influenced the designers

tions reports that it buys materials, parts, and services from more than 10,000 American firms. These include, of course: rail, water, highway, and air transportation; consulting engineering talent; attorneys not on the corporation's payroll; architects and industrial engineers; and the plethora of skills, buildings, and equipment needed in the complex structure of a single company.

The realistic engineer knows that a wild-cat strike, a war, or a depression will throw the entire manufacturing structure out of gear. Except in his role of a citizen, such impacts are beyond his control. But he has learned, in the automotive



public opinion surveys must suffice in these days of millions of users and potential users of products produced in large volume. But the design engineer most likely to succeed is the man who is adept in adopting good ideas and who successfully applies them to his own design.

EXPERIMENTAL ERA—Taken because of its clarity, the history of the Ford Motor Company delineates the pattern of growth in the industry from the standpoint of coordinating design with production techniques. This pattern is just as true with the other older companies, such as Studebaker, Packard, White, and Mack, as well as the older component and parts companies.

The first published description of a Ford car, with photographs, was a single seater, with high, buggy type wheels, tiller steering, and an open flywheel on the engine just aft of the seat. It was a horseless-carriage with a bicycle acetylene lamp for a headlight, born in a small brick blacksmith shop. The Ford outgrew its buggy look through a series of models up to 1907 when it had become a six in the model "K" version, with the four-cylinder models "R" and "S." This was the era of mechanical experimentation, and sounding out public tastes in motor cars.

In the meantime other manufacturers were experimenting day and night, taking the pulse of public opinion. Some specialized in large, hand-made, expensive vehicles. Other firms concentrated on small cars for the low price bracket. But all of the cars of that period showed clearly that advances had to be made in metal working techniques before prices could be reduced. Fenders and hoods had riveted seams. Body panels were produced on metal bending brakes. Only the expensive

cars boasted of running boards, while for years the carriage step sufficed. Expensive cars had surrey tops, with fringe and all the trimmings, and were the pride of the carriage builders who ventured into the new and unexplored field of the horseless-carriage.

FIRST MASS PRODUCTION—Then, beginning in 1908, came the era of the famous model "T", with its jokes, with its reputation for getting there and back home again, and with the wedding of the interests of the designers and the men in the shop. The beginnings of mass production in that era made the Ford a vehicle of universal transportation, a fact its maker advertised in every land where streets were at least dirt roads, and where towns were connected with roadways a little better than cow paths—sometimes.

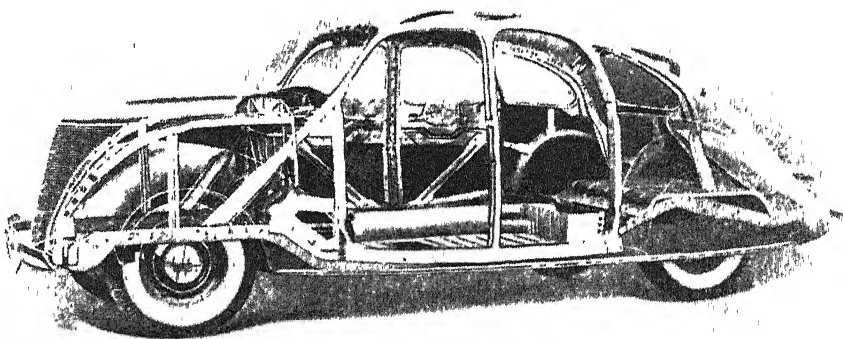
The problem paramount in that period was to make a sturdier car at less cost. Factories were small, and designers and shop foremen called each other by nicknames. Simplification in design was the watchword and it became a credo. Many a designer was told by his boss: "That looks all right, Son, but ask Joe in the shop if he can make it—and for how much."

Thus the production engineer emerged as the wonder boy of an era of American industry, and the

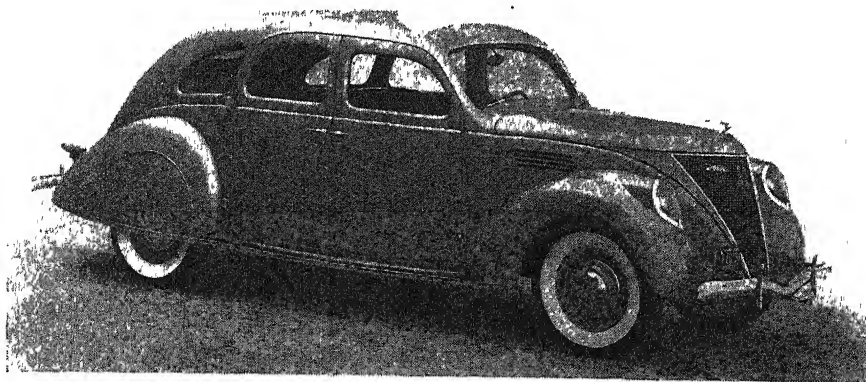
designer found out all he could about how products were made if he remained on the payroll. With the name of Henry Ford, the names of William S. Knudsen, Charles E. Sorenson, Walter P. Chrysler, K. T. Keller—and a host of others—emerged in newspapers and became a part of America's vocabulary. More and better jobs were provided through the techniques developed by these men despite the detractors who loudly protested that a mechanized age would reduce wages, cut employment, and decimate the American standard of living.

Because no vehicle is completely manufactured by the maker, but is assembled from a vast industry of more than 3500 companies supplying fabricated materials, parts, component sub-assemblies, chemicals, paint, tires, and other supplies, every participating manufacturer or supplier either had to get on the correct side of the mass-production philosophy or go out of the automobile industry altogether. They, and the vehicle manufacturers, stimulated the machine tool industry to produce increasingly faster machine tools and presses with automatic features.

The basic elements of mass production depended on obtaining parts built of the correct materials and finished to dimensions set by the producer of the end product. Di-

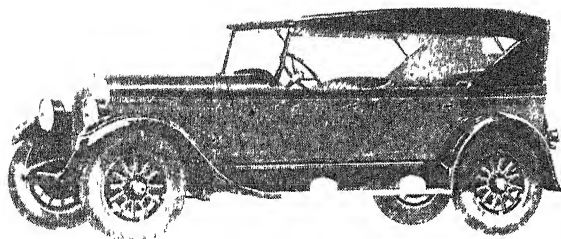


All steel body design, incorporating a rugged underlying structure (above), and emphasizing (below) clean, eye-pleasing, exterior contours, allows the automobile designer great license and represents many years of experiments



mensional tolerances had to become an inviolate rule so that interchangeability could become a fact. The day of the file and hand fitting of parts was doomed as the glimmerings of a mass-production economy were brightening the industrial horizon while war clouds were gathering in 1913 and 1914.

A case in point was the production program of the Liberty engine of World War I. The planners of the project envisioned many American machine shops working on parts, which would be shipped to a few large engine plants for assembly, test, and shipment to Europe. To achieve this laudable goal, dimensional tolerances had to be held to



Advancements in sheet-metal working techniques were apparent in the curved body-panels and fenders of the first Chrysler car

dustrial economy, the engineer who achieves success will be the man or woman who realizes that the days of the chaste and isolated ivory tower of engineering are gone, and whether he likes it or not, the engineer must widen his viewpoint to include economic and industrial factors that may have heretofore appeared to have been none of his business

a minimum. But too few shops had the machine tools or the know-how to hold parts they built to sufficiently close tolerances to finish the program. Some factories, which were large enough to build the parts themselves, produced the engine satisfactorily, although the projected goal was never met.

MODERN TECHNIQUES — The third important automotive design and production era may be said to have begun in 1924 with the introduction of the first Chrysler. By that time, manufacturing techniques had caught up with the designers' dreams. Streamline styling was possible on a mass-production scale because enough experience had been gained in sheet metal pressing and stamping to produce the required curves. This period also falls roughly in the third era of the Ford, with the introduction of the model "A" in 1929 and closing with cessation of production on the eve of World War II.

It was in this period that color was introduced and the highways glistened with colorful low-priced cars. Again, the stylists had to wait for the chemist to produce a finish which could be applied at a low cost. The vast amount of research in synthetic resins and even iridescent finishes containing ground fish scales, resulted in a resplendency of automobiles and trucks which were beyond the fondest dreams of the veteran natural varnish finishers insofar as low cost and permanency were concerned.

Such men as Alfred P. Sloan had a hard time to get their associates to believe that the man-on-the-street and Mr. Average Motorist would prefer a colored car to a black one. With the color finishes came rainbows of upholstery hues, chromium plated grilles and hardware; metal trim reflected the sun's rays from coast to coast. The magic of chemistry made all this possible, and the designer who failed to grasp this opportunity and seek more acceptable color combinations to intrigue customers, missed an important boat.

The buying public clamored for more. So the stylist's version of

streamlining came along as soon as the machine tool industry, the steel mills, and the welding experts had developed presses, proper types of steel, and fabricating improvements to turn the blue prints into a vehicle. Giant presses dwarfed their predecessors as the development of the Fisher all-steel body came along. Deep drawing of low carbon steel was an "impossibility" that took time and money to lick. A number of steel mills actually constructed new continuous sheet and strip rolling plants where but a short time before the tall corn grew. Millions of dollars were invested to rehabilitate existing plants to produce miles of wide, mirror-like steel sheets. One of the ramifications involved in producing the designers' dreams was an intense research in the deep drawing qualities of low carbon steels in steel mill metallurgical laboratories, and another was a remarkable achievement in butt welding the thin sheets; a project to which fabricators and resistance welding equipment manufacturers made notable contributions.

FUTURE CARS—It is against this background, and the telescoping of several decades of manufacturing developments and materials researches during the recent war, that the inventor must place his ideas and the designer his prospective product. The development, manufacture, and merchandising of a product as simple as an improved fountain pen is a project of major dimensions these days, as compared with the pioneering era which made the name Waterman a household word.

It appears that the post-war era of the American automotive industry will have plenty of room for sound, ingenious engineering thinking. Many an older idea, long since discarded because materials research and manufacturing developments were not ready, will be dusted off and adapted to improve the automobiles of tomorrow. Competition in ideas will be keener because the nation and the world is more "science conscious" than ever before in the history of mankind. But in view of the structure of our in-

FLYING CARS

Require Radical Changes in Design

FURTHER development of the idea of a hybrid flying automobile is in its test stage by the Stout Research Division of Consolidated Vultee Aircraft Corporation. Although the present version is designed chiefly as an airplane and secondarily as an automobile, some of the engineers working on the project hope to improve the suspension for greater roadability. In the air and on the road, it is driven with a pusher propeller, recalling the earlier days of aircraft design.

A feature of this version of the Stout Skycar is the wing design which eliminates the need for ailerons, rudder, and elevators.

PLASTICS WINDOWS

Seen as Possibilities in Automotive Vehicles

AUTOMOTIVE engineers and plastics experts are exploring the possibilities of transparent plastics for glazing automobiles. The Safety Code for Safety Glass, developed several years ago by the American Standards Association, has become the basic document for state regulations. Advent of transparent plastics, some engineers believe, may result in additions to the ASA code, or may require a new code covering the new materials.

Automotive engineers have asked plastics specialists to compile the physical properties of various materials, which they will study with a view to making recommendations as to the prospective use of some of these plastics in automobile and bus windows.

According to current opinion, none of the plastics materials will be suitable for windshields, due to the abrasive effects of windshield wipers. The plastics experts have indicated, however, that a number of improvements in the materials are looming on the horizon.

Industrial Uses Of Atomic Energy

Will Future Automobiles, Trains, and Ships be Powered by the Often Mentioned "Spoonful" of Material that can be Converted Into Useful Energy by Atomic Fission? Size of Power Plant, Economics of Power Source, and Other Factors, Enter the Picture

By LEONARD I. KATZIN

PRE-WAR prospectuses of the benefits to be expected of atomic power included automobiles with power supplies built in for the life of the machine or, alternatively, "power pills" good for at least 2000 miles of travel. Small black boxes were envisioned to supply power to light, heat, and air-condition the city home, or to furnish all the power needed on the farm. Similar black boxes were to power airplanes which would then circumnavigate the globe without stopping or might even make trips to the moon. Coal-mining was to be a relic of the past, and prosperity was to be the lot of all.

On August 6, 1945, came the official announcement that the "Atomic

One pound of U-235 = 11,400,000 kilowatt-hours = 1500 tons of coal = 250,000 gallons of fuel oil = 80,000,000 cubic feet of artificial gas = 40,000,00 cubic feet of natural gas.

Age" was actually here. It then became necessary to retrace our steps and to re-evaluate our judgment on the future.

EINSTEIN FIRST—Since 1905, when Albert Einstein first formulated the equivalence of mass and energy, scientific imagination has been busily exploring the possibilities of obtaining practically unlimited supplies of energy from the transformation of small amounts of common materials. The discovery of nuclear transmutation reactions by Rutherford, in 1919, indicated one possible means of causing this interconversion. It was found that in many nuclear transformations a net loss of mass occurs, which is equivalent to the amount of energy released in the

transformation. This source of nuclear or "atomic" energy has been investigated extensively but has been found to be of no practical significance because of the small scale on which transformations could be accomplished. Only a few atoms could be metamorphosed at a time. In many cases, the bombarding particles necessary to accomplish these transformations could be produced only with the expenditure of very considerably larger amounts of energy.

In 1938, the experiments of Hahn and Strassmann in Berlin proved that the so-called "transuranic elements" produced by Fermi, in 1934, upon bombardment of uranium and thorium with neutrons, were actually radioactive isotopes of elements from the middle of the periodic table. This indicated that the reaction occurring was a totally new one; namely, fission of the uranium or thorium nucleus into large particles. Further physical investigations showed that energy was released in this process corresponding to about 200,000,000 electron volts (about 0.00032 ergs) per fission. This amount of energy, corresponding to conversion of approximately one quarter mass unit per atom, is the largest single nuclear reaction energy known. For comparison, the heat of combustion of a molecule of TNT is only about 35 electron volts.

Further investigations showed that the disintegration process releases, in addition to the fission fragments, from one to four neutrons. The possibilities are thus present for a chain reaction, in which the fission of one uranium nucleus by a neutron gives rise to more neutrons, which in turn may be absorbed by other uranium nuclei to give a self-propagating chain of energy release. This represents the first type of nuclear reaction found that justified considera-

EDITOR'S NOTE—The accompanying article was prepared at the suggestion of the "Atomic Scientists of Chicago," one of the groups which collaborated in the construction of the atomic bombs. In the text is given a calm and dispassionate evaluation of the probabilities of future uses of atomic power, as viewed by men of science closely associated with current developments. Every effort has been made to free this discussion from the hair-trigger sensationalism that has been attached to the subject since the first atomic bomb fell on Japan on August 6, 1945.

tion as a practical source of energy from the interconversion of mass and energy.

U-235 AND U-238—The further discovery was made that it was the scarce isotope of uranium, U-235, present to about 0.7 percent in natural uranium, which was the one readily undergoing fission. It was realized that isolation of this isotope would solve most of the problems involved in devising a chain-reacting unit, but it was equally evident that the separation of heavy isotopes with such a small difference in mass could be extremely difficult, and that such a separation on a large scale would be a major undertaking. The use of natural uranium itself was an intriguing possibility, but the problems introduced by the relatively inert abundant isotope, U-238, made it uncertain whether a chain-reaction could be achieved using unseparated uranium.

It was vaguely recognized by a number of workers that the use of some slowing-down material to keep the neutrons in the vicinity of the uranium, and to take advantage of the increased capture reaction of the U-235 with slow neutrons, would be helpful. At this point, war-time security curtains were dropped on the discussion of atomic energy and on the work underway on its development.

With the partial lifting of the secrecy curtain again in August, 1945, it was revealed not only that U-235 had been separated from the common isotope, U-238, and could

be used to give an explosive chain-reaction, but that the problem had been solved of obtaining a chain reaction with unseparated, natural uranium. A few comments may be made on the basic principles of the chain reaction thus revealed.

It is typical of all known chain-reacting fission systems that there is a minimum or "critical" size below which they will not function. This critical size is influenced by the shape of the structure, and by its composition—that is, whether it is pure U-235, or U-235 mixed with U-238 and/or other substances. (In the discussion from here on one may read plutonium-239—the new synthetic isotope, which is similar in many of its properties to U-235—instead of U-235.) The physical picture for this is rather simple. To maintain a chain reaction, a portion of the neutrons given off in fission must be recaptured by U-235 atoms to give at least an equal number of "second generation" fissions. The neutrons are given off in all directions, and may be lost by leakage from the structure. If the volume-to-surface ratio is high enough, the neutron loss through leakage is below the critical amount, and the chain reaction may maintain itself. In order to help keep this surface leakage down in non-explosive ap-

with a structure of infinite size. In non-explosive uses of the chain reaction, advantage of this behavior is taken to control the structure. Highly absorbing strips of cadmium or boron steel are inserted to the point that only one neutron per fission is left to give another fission. In this fashion, a steady power level may be maintained.

From this extremely brief description one outstanding fact emerges: It is not proper to think in terms of a power source of a gram or a fraction of a gram of U-235. No matter whether one wants much power or little power, the same irreducible minimum of U-235 must be used. From the official Smyth Report on atomic energy for military purposes it is learned that the critical amount for pure U-235 is somewhere between two pounds and 220 pounds for an explosive reaction. If use is made of one of the moderators mentioned earlier, the critical amount of uranium may be expected to be somewhat less than for the metal alone. For unseparated uranium, it is necessary to multiply the critical values by a factor of 140, the ratio of the weight of U-238 in the mixture to the weight of U-235, so the limits become 300 pounds and 11 tons, respectively. This weight, of course, does not include the moderator.

Any savings in uranium weight due to the use of a moderator are more than counter-balanced by the "poisoning" effects of neutron absorption by the U-238. The Smyth Report tells that, with a graphite moderator, over six tons of uranium metal together with an unspecified amount of uranium oxide are needed to achieve the chain-reacting condition, so the 11-ton upper limit may be near the truth for this moderator. The weight of the graphite in the structure could not be much less than this, so the minimum weight of a chain-reacting graphite-moderated "pile" (to give the structure its common name) must be taken as on the order of 20 tons. The unit working with pure U-235 may be considerably less, but can hardly be less than several hundred pounds.

RADIATION HAZARD — Another extremely important factor affecting the size of the atomic-power structure is the radiation hazard. A chain-reacting pile, operating at even low power levels, is the source of tremendously intense beta-, gamma-, and x-radiation, in addition to neutrons. The equivalent is that of many pounds and even tons of radium. Shielding is necessary and, for a high-energy pile, consists, at a minimum, of two or three

feet of steel, or several times that amount of concrete. Such shielding adds to the weight and bulk of the pile.

A third item which makes the pile a sizeable machine is the very necessary cooling system. Without efficient removal of the heat generated, temperatures high enough to fuse the structure of the pile would be

"Not only will it be impossible to have an indefinitely small nuclear power source based upon fission of uranium, but any such power source must be heavy and awkward, and quite dangerous. . ."

readily attained, if the power level were designed to be more than just a few watts.

Summarizing these points, it becomes clear that not only will it be impossible to have an indefinitely small nuclear power source based upon fission of uranium, but any such power source must be heavy and awkward, and quite dangerous in case of mishap of one sort or another. These points of themselves rule out the pre-war dreams of the automobile with the life-time power-supply built in, or of the power pill which could be substituted for gasoline. Any visions of individual atomic power units for every home or farm must also be abandoned, so long as uranium fission is to be the source. Bulk and weight of the atomic power plant make equally illusory its use in airplanes for the purpose of eliminating the decrease of the useful load capacity by the fuel load. In fact, it is questionable whether any conveyance should carry such a dangerous type of power-plant. Railroad engines certainly do not need it, being adequately driven by the usual heat engine, electricity, or the mercury vapor turbine. It might perhaps be a moot question whether an atomic power plant would prove useful on a seagoing vessel. This would depend primarily upon the extent to which increases in useful cargo space at the present time are limited by required increases in the propelling mechanisms. It has been estimated that fuel costs are only 12 percent of the operating costs of a 17,000-ton liner.

In a negative fashion, perhaps, it has been indicated that the possible use of atomic power plants is at present best restricted to stationary, high-power units. An idea of the possibilities of the pile in this direction may be gained in rough fashion by comparing the size of Mussel Shoals, Boulder Dam, or Grand Coulee, with, say, a big-city power

"Atomic power plants . . . must be reserved for the special purposes for which other types of power are not so well suited."

plications, a "slowing-down" medium or "moderator" (graphite, beryllium, heavy water) is used to keep the neutrons in the vicinity of the uranium. This in turn lowers the critical amount of uranium to be used, compared to that when no moderator is used.

ABSORPTION OF NEUTRONS—In addition to the loss of neutrons through external leakage, some may be lost through what may be called "internal leakage." This is the absorption of neutrons in the chain-reacting structure in such fashion that fission does not occur. One such loss is by absorption in the moderator, another is by absorption in the U-238 (if present), and a third is by an occasional absorption in the U-235 which does not lead to fission. A fourth source of loss is in chemical impurities in the uranium which may absorb disproportionate numbers of neutrons. It is readily seen that if these "internal leaks" are high enough, the chain-reacting condition will not be reached even

substation. Although perhaps not precise, this comparison gives an idea of the comparative magnitude of the physical installations involved for million kilowatt power outputs through water power and uranium fission, respectively. Besides the lesser physical size of the atomic power installation, there are the advantages of its independence of large and constant sources of flowing water, a condition which automatically determines the location of water-power plants.

ATOMIC POWER INDEPENDENCE

One of the biggest virtues of an atomic energy power plant is its essential independence not only of natural restrictions, such as water-courses, but of large fuel supplies

"It is questionable whether any conveyance should carry such a dangerous type of power plant."

and of the large-scale transportation these make necessary. As will be pointed out, the energy output of a pound of U-235 is about that of 1500 tons of coal. The relative transportation problems need no further elaboration. This freedom from the demands of large-scale supply makes possible exploitation of the values inherent in building power installations close to the sites where they will be most useful, diminishing power distribution costs in some cases, and perhaps, in others, opening up to development many regions which are rich in natural resources but which otherwise might not be readily tapped. It therefore becomes necessary to consider the economic aspects of atomic power development.

A pound of uranium-235, completely consumed by fission, will give a total of some 11,400,000 kilowatt-hours of energy. This is roughly equivalent to half a day of operation at a power level of one million kilowatts, a power level that Professor Robert Oppenheimer has said he believes commercially attainable within five years time. It must be pointed out that this figure for energy release by fission is some 0.1 percent of the total energy-equivalent of the mass involved, because only about one quarter of a mass unit is consumed in the fission process, out of a total of 236 units (235 plus the neutron). Equivalent amounts of energy are released by combustion of roughly 1500 tons of coal, 250,000 gallons of fuel oil or gasoline, 80,000,000 cubic feet of artificial gas or 40,000,000 cubic feet of natural gas.

By making the possibly incorrect assumption that the U-235 is consumed with the same efficiency as are the combustion fuels with which it is being compared, and assuming that its efficiency of conversion to electrical energy is the same (see below), we may obtain the following rough comparisons. In order to compete with bituminous coal at \$5 a ton (approximately the 1942 wholesale average), a pound of U-235 must cost not more than \$7500. To compete with fuel oil at three cents a gallon, it must again be as low as \$7500. Competition with 15 cent gasoline is effective at \$39,000 a pound. To compete with artificial gas costing fifty cents a thousand cubic feet it may still cost \$39,000 a pound, while natural gas at the same price would demand a competitive price of about \$20,000 a pound. Present information does not allow estimation of the cost of pure isotope U-235 in routine mass production; the government figures released on the costs of the atomic bomb projects give no indication of this. It may therefore be better to consider the cost of unseparated natural uranium, which may be readily used in some kinds of piles.

URANIUM COST — The pre-war market price of uranium, in the form of the nitrate, was about \$7 per pound of element. Uranium metal, which was a rarity before the

"No matter whether one wants much power or little power, the same irreducible minimum of U-235 must be used."

war, and which the Smyth Report indicates is necessary in especially pure form for pile operation, may be several times more expensive. Using, for a round number, an arbitrary \$20 per pound as the cost of metal ready for the pile, and remembering that 140 pounds of uranium are needed for one pound of U-235, the apparent cost of a pound of U-235 is perhaps on the order of \$2800. This does not include any additional cost of processing, nor allow for plant installation costs. However, the Smyth Report indicates that part of the U-235 consumed in the pile is replaced by plutonium-239 which is formed from U-238 following capture of a neutron. The formation of the fissile plutonium isotope acts to raise effectively the "fuel value" of the uranium by indirectly consuming part of the U-238. It is guesswork to estimate the extent of this effect without more information, but it is not impossible that the ef-

fective amount of U-235 is thus doubled or even trebled. Operating in the opposite direction, of course, are unknown factors determined by operations or conditions peculiar to the pile. The extent of influence of these factors can not be estimated without further information.

FAVORABLE COMPETITION — On the basis of the discussion so far, U-235 would appear to be a power source capable of competing quite favorably with the conventional coal and petroleum fuels. It is necessary to indicate, however, that the largest factor in costs of power delivered to the consumer is that of distribution costs, and the costs of the manufacture itself are usually estimated as only 15 to 20 percent of the total. Thus even a marked decrease in the cost of production of power would not necessarily result in a proportionate decrease in the cost of power distributed to the consumer.

It is important further to consider the total fuel consumption of the United States. Thus, in 1942, according to the publications of the Bureau of Mines, approximately 640,000,000 tons of coal were mined and consumed. On the basis of 1500 tons of coal being equivalent to one pound of U-235, this would correspond to a consumption of about 220 tons of U-235. The production of natural gas for the year 1942 was 3,000,000 million cubic feet, or the equivalent in energy of approximately 40 tons of U-235. Similar figures may be calculated for petroleum products. Turning attention to electrical power, it is found that for 1942 the capacity of the electrical generating plants of the United States was about 46,000,000 kilowatts. This corresponds to a consumption of four pounds of U-235 every hour or some 18 tons of U-235 in the course of a year.

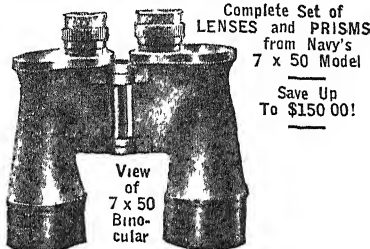
Published estimates of the uranium in sight from the several large pre-war producers of this mineral (the United States, Czechoslovakia,

"Any visions of individual atomic power units for every home or farm must . . . be abandoned, so long as uranium fission is to be the source."

Belgian Congo, Canada, and Russia) indicate a total of about 20,000 tons of uranium readily available. About half of this estimated, immediately-foreseeable uranium is present in the United States and Canada. It is clear that even if it proved practical to consume more than 0.7 percent of the uranium in fission, the long-time importance of uranium as a

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6159-S	23	51	1.25
6161-S	24	48	1.25
6162-S	25	122	1.25
6164-S	26	104	.80
6165-S	27	187	1.00
6166-S	29	54	1.25
6168-S	29	76	1.25
6169-S	31	122	1.50
6171-S	32	171	1.00
6173-S	34	65	1.00
6176-S	38	131	1.00
6177-S	39	63	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25

*ASTERISKED ITEMS are uncemented, but FREE cement and Directions included with uncemented sets.

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26-S	First Surface Aluminized Mirror, Diam 1 1/4" Each	.25
624-S	Neutral Ray Filter size 4 3/4" x 2 1/4"	.25
3022-S	Round Wedge 65 mm Diam Each	5.00
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3045-S	Right Angle	70 mm	168 mm	8.00
3001-S	Lens Surface	20 mm	14 mm	2.00
3009-S	Porro	52 mm	25 mm	1.00
3016-S	Pentagon	45 mm	22 mm	.75
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source of ordinary power in competition with coal, oil, and gas fuels would be minor. Atomic power plants, therefore, must be reserved for the special purposes for which other types of power are not so well suited, as has already been suggested above.

MAINLY HEAT ENERGY — The question is often asked, whether there is any peculiarity of the energy released by nuclear fission which enables it to be more efficiently used than energy available from more familiar sources. For the present, at least, the answer must be that fission energy is mainly heat energy liberated through collisions of the extremely energetic fission fragments and neutrons. A rather minor portion of the fission energy is due to other radiation given off in the pile. As heat energy, it is susceptible to the classical methods of conversion of heat into work.

The unique characteristic of heat generated by the pile is that the temperature which may be attained is limited only by the operator's desire to maintain the physical

characteristics of the materials of construction. With ordinary fuels, the heat of reaction and rate of combustion set limits on the temperature which may be reached. In the case of the pile, the problem is to keep the temperature down to the limits set by the physical structure. Because of this characteristic, it is theoretically possible to operate a power cycle at such an elevated temperature that the efficiency of the conversion of heat into work is greatly increased.

In summary, it may be said, although atomic power is probably cheap enough to compete with the common fuels as sources of energy, the materials are so scarce as to make uneconomic their random use. Although atomic power installations based on uranium fission are not minute, their power output for unit size can be disproportionately high when compared with other types of sources. The coupling of small size and independence of large fuel supplies or watercourses, however, gives the pile certain unique values in situations in which these characteristics are important.

water where the craft or vessel itself will float. This ability opens new fields to marine commerce—factories, plantations, towns, and cities which until now have not been “on the channel.”

With the Harbormaster, possible damage to propulsion and steering apparatus is cut to a minimum because of a patented shear pin. When an immovable submerged obstruction is struck, this pin shears off, allowing the vertical assembly to ride up and backward *over the obstacle*, free from damage and without the loss of forward motion. In the matter of a minute or so a new shear pin can be inserted while under way!

Harbormaster models, both gasoline and Diesel, range in power from 45 to 300 horsepower.

PUBLIC RELATIONS

*Important to Business
And Industrial Executives*

TOMORROW'S business and industrial executives will need to be “as familiar with human relations involving public attitudes and customer relations as yesterday they were experts in the field of production and sales,” declares Paul Garrett, vice president of General Motors Corporation, in an article for the Annual Directory Issue of *The Constructor*, official publication of the Associated General Contractors of America.

“Leaders of industry who are blazing new trails in industrial management are men of this type,” he explains. “And 10 years from now business leaders will have become more expert in this new field, just as they have always learned to become expert in every field on which industrial progress depended.”

Recent major problems of business have not stemmed directly from the traditional subdivision of business at all, he continues. They have had to do with such things as taxes, labor unions, governmental regulations, community relationships, and so forth. These problems bear about as importantly on business operation today as designing, engineering, or production.

“If there is any secret to success in building good public relations,” Mr. Garrett asserts, “it is that you must start at home and work from the inside out. Good relations outside grow from good relations inside. If the immediate family is not happy and informed, those whom it meets on the outside will not be. To outsiders those who work for a company are the company—and outsiders judge the company by the folks in the company they know.

PROPULSION UNITS

*Bring Flexibility of Operation
To Many Marine Craft*

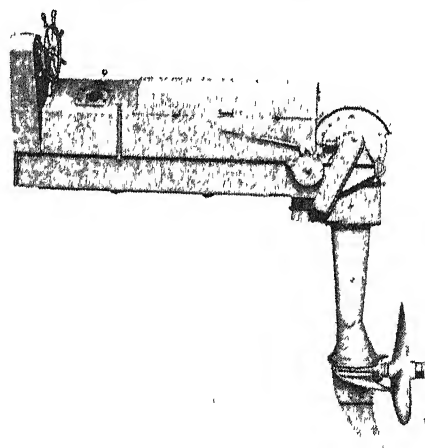
TAKING a few leaves from outboard-motor history, large propulsion units using Diesel or gasoline engines have been proved in war action all over the world and now offer marine commercial operators a high degree of efficiency of operation and maintenance. These operators can now have the maneuverability they have so often envied in small boats equipped with the conventional sport-type outboard.

The Navy uses these units on “Rhino Ferries” and “Rhino Tugs,” and it is probable that they will be used in great quantities as outboards on small barges, scows, lighters, tugs, fishing smacks, dredges, pile-drivers, and many other work vessels, but this is by no means the limit of their applicability. They can be used on any barge or vessel that will allow the submersion of the propeller.

One of the outstanding features of the “Harbormaster,” as these units, made by Murray and Tregurtha, are called, is the 360-degree propeller thrust steering. Here, for the first time in commercial marine history, operators have instant control with power by simply turning the large steering wheel. This is

possible because steering is done by the thrust of the propeller itself and the propeller can turn through a complete circle, thus avoiding the limitations of rudder steering.

Another feature is the 180-degree elevating mechanism. With this, the



Heavy-duty marine propulsion unit with steerable propeller that can be tilted completely out of water

one-man operator can angle the entire submerged section out and backward to a position directly overhead, if necessary for repair work. The elevating mechanism has another important function in that by angling the submerged section to say 20 or 30 degrees, or even 45 degrees, power and steering can be maintained in shallow or reef-filled

RAMSDEN OCULARS

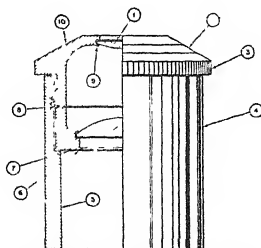
We are introducing a new ocular designed for astronomical and precision optical instruments. This design is the result of many years of experience in the use of all types of optical instruments. Resolution, efficiency, and comfort are the paramount considerations in eyepiece design. We therefore invite you to check the following design points against any existing eyepiece.

1. Highest quality lenses produced from B&L optical glass, pitch lapped surfaces, accurately centered and edged. All surfaces coated with magnesium fluoride in accordance with Navy specifications to give a hard, durable, anti-reflection coating, increasing the efficiency approximately 10 percent over uncoated optics, and reducing glare.

2. Recessed eyelens mount, giving greater comfort, particularly with shorter focal length oculars

3. Milled rim to facilitate focusing by "wringing"

4. Standard size 1 1/4" outside diameter — body of non-oxidizing Dural



TYPICAL EYEPIECE

5. All interior surfaces black anodized, producing a permanent, non-scaling, non-reflecting surface.

6. Field stop in the focal plane giving sharp definition by limiting unwanted oblique rays

7. Surface mount for reticules or stadia hairs. This surface is in the focal plane for the normal eye and facilitates any setup for angular measurement.

8. Simple, three-piece construction to facilitate cleaning the lenses.

9. Lenses accurately spun into place with jigs to insure perfect, permanent centering

10. Near surface black anodized to eliminate unwanted reflections from the eyelens mount

We are supplying these quality Ramsden eyepieces in the following focal lengths: 1 1/2", 1", 3/8", 3/8" and 1/4". These sizes have been selected to give the greatest utility for general work. Note that they form a progression converging by 1/8" increments.

The price for each eyepiece is \$8.00 postpaid in U.S.A. This is possible only through use of automatic screw-machine set-up and modern

optical production techniques. We are supplying to those who purchase a full set, a hard wood dust-tight case for the eyepieces.

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Send your check or money order today, to be assured of prompt delivery. Do not send cash.

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"How the employment office hires, what the foremen do, how the paymaster pays, and how the management conducts itself—these are the ABC's in the building of harmony in the company family.

"With good relations inside the plant, you have the base for good relations with the public outside. But you can never take those relations for granted. Living right is not enough. People must know you live right

"The art of public relations is in the art of multiplication—that is, the art of multiplying endlessly the good impressions of a company."

WOOD TREATMENT

*Introduces Chemicals
Into Sap Stream*

SCIENTISTS of the United States Department of Agriculture have de-

veloped a method by which farmers and other users of wood-lot trees can introduce chemicals into the sap stream of the wood to increase the length of service of fence posts, bean poles, garden stakes, and other utility poles.

The method is neither difficult nor expensive to use. The fresh-cut saplings are simply allowed to stand in a wooden tub or trough containing the right amount of chemical in solution for a period of about six hours or until they have taken up the required amount of chemical.

Chemicals recommended include chromated zinc chloride, zinc chloride, and copper sulfate (blue-stone), of which the chromated zinc chloride is reported to be the best. The chromated zinc chloride is twice as expensive as zinc chloride or copper sulfate, but it protects the wood longer, and is also less corrosive to wire staples than copper sulfate. One pound of either of the chemicals dissolved in a half gallon of water will treat one cubic foot of wood.

Best results are obtained when the saplings are treated immediately after cutting. When it is not possible to treat them soon after cutting, or if the pitch oozes out of the soft woods, about one inch should be

sawed from the cut end immediately before treating to permit the chemical solution to enter the sap stream. The lower branches may be removed for convenience in handling, but a few upper branches left attached will hasten the treating process by facilitating sap movement.

Many kinds of both hard- and soft-wood saplings or trees of a size easily handled can be treated by the sap-stream method. Pine trees are more effectively protected against damage by insects and decay than are many hard-woods. The treatment is best applied during the spring and summer, particularly on bright sunny days, when the sap flows most rapidly. Hardwoods can be treated only from early spring to late summer. Pine trees can be treated any time except during freezing weather. Evergreens, treated in winter, require about a day to take up the necessary amount of solution.

The method of introducing chemicals into trees and poles through the sap stream has been known to scientists for years, but until recently the method has not been practicable for use by farmers. The scientists warn that all of the recommended chemicals are poison-

ous and should be kept out of the reach of children, pets, and livestock. None of them should be stored in metal containers. Because copper sulfate is corrosive, it must not be used in metal tubs or troughs.—*Timber Topics.*

EXPLOSIVE RIVET

*Can be Set
Without "Bucker"*

AN EXPLOSIVE rivet especially adapted to meet the demands of



Setting the new explosive rivet

peace-time mass production methods is the latest development in the explosive type of "blind" fasteners used extensively by the aircraft industry during World War II. They are fastened in place by firing a small explosive charge within the shank of the rivet.

Retaining basic features of previous types, the improved design eliminates the necessity for close tolerance drilling and provides rivets which will accommodate a wide range of metal thicknesses. These features are in direct contrast to those of the explosive rivets supplied to aircraft manufacturers where precision tolerances and a wide variety of lengths were required.

After explosive rivets are in place, the tip of an electrically heated iron is applied to the rivet heads. Heat fires the explosive charge within approximately two seconds. The shank of the rivet is thus expanded to fill the hole completely and a barrel-shaped head is formed on the "blind" end to lock the rivet securely in place. The strength of these rivets is only slightly less than that of conventional solid rivets.

These improved rivets are now provided in 1/8, 5/32, and 3/16 inch diameters, the Du Pont Explosives Department says, and will be produced in additional sizes. They are made of various materials including several aluminum alloys, brass, copper, mild steel, and Monel

explosive rivets will be useful in

the automotive industry for construction and maintenance of chassis, bodies, accessories, and parts. In refrigeration—cabinet construction for farm and home freezers, locker plants, commercial refrigerators—explosive rivets will be helpful at many points.

They are well adapted for the construction of prefabricated housing, for attaching paneling and similar applications. They will be suited to the construction and sealing of air-conditioning ducts and in the heating and ventilating field for the fabrication of furnaces, stokers, and housings.

LIGHTER WICKS

*Now Braided of
Asbestos Yarn*

A CIGARETTE lighter wick that practically never requires trimming or replacement is the latest thing to come out of the textile research laboratories of United States Rubber Company.

Made of asbestos yarn, the new wick is tightly braided to prevent fraying and "blossoming" which frequently puts lighters out of operation, the company announced. A small core of glass yarn provides improved capillary action for proper feeding of fluid.

Textile engineers developed the braided wick during experiments with Abeston, a fire-resistant fabric used in ironing board covers. Wicks were formerly twisted instead of braided and they had a tendency to unravel, producing a flickering, smoky flame, the researchers reported.

HIGH-SPEED TIMER

*Works to
1/10,000 Second*

HOW FAST is pitcher Bobby Feller's "fast one?" How slow is a "slow ball?" How many miles per hour does one of golfer Byron Nelson's drives travel? How fast is one of gridder Sammy Baugh's "bullet" passes?

Long a matter for conjecture on the part of sporting hot-stove leagues, such speeds are just a few of many that can be clocked scientifically by the General Electric time interval meter, versatile electronic device with a variety of uses.

Capable of checking extremely short time intervals, ranging from three seconds down to 1/10,000th second, the time interval meter can measure velocity of any moving body, can determine speed of a camera shutter, can check synchronization of flash and shutter on a cam-

era, and can test electrical relays, according to G-E electronics engineers.

In measuring speed of a moving body, be it a baseball, football, golf ball, or even a rifle bullet, two photo tubes with light sources aimed on them are set up at a known interval apart directly in line of flight of the moving body. The light sources shining on the photo tubes create two beams of light.

The meter begins timing when the moving body in flight breaks the first beam of light and ceases timing when the moving body breaks the second beam. Amount of time consumed between breaking of beams is indicated in milliseconds on the meter dial. With the distance between beams known, the speed of the moving body can be computed accurately.

ALUMINUM PLATES

*Reduce Weight
In Pianos*

A PIANO plate of cast aluminum alloy, 80 pounds lighter in weight than the ordinary iron plate used in these instruments, is now in production. The successful development of the aluminum piano plate by the Aluminum Company of America, and Winter and Company, piano manufacturers, was aided materially by a new stress coat analysis method developed at the Massachusetts Institute of Technology. This method, made commercially available through the facilities of the Magnaflux Corporation, consists essentially in covering the metal with a coating of brittle lacquer and then stringing the plate. The pattern which results when the lacquer



The new light-weight aluminum plate for pianos weighs only 45 pounds as compared with 125 pounds for the older type. This reduction in weight makes for a more easily movable unit

cracks under tension of the piano strings is then analyzed. Strain gages and special electronic equipment are used to complete the analyses. The result of these stress analyses led to a more economical and scientific distribution of the metal which further lightens total weight without sacrificing strength. It was in the development of the aluminum plate, called Alumatone, that this technique of stress analysis was first applied to problems in piano construction. The aluminum plate results in a piano that can be moved around without effort or strain, the light weight of the instrument reduces wear and tear on rugs and carpets.

SANITATION

*Increased by Complete
Destruction of Bacteria*

NEW GERMICIDES tried out in the bacteriological laboratories at the State Experiment Station at Geneva, New York, have resulted in the complete destruction of bacterial life within five minutes after exposure of the organisms to concentrations as low as one part of the germicide in 20,000 parts of water.

The new materials are known as "quaternary ammonium compounds." While not yet generally available, all data so far collected by the Experiment Station food bacteriologists show a definite future for their use in sterilizing procedures in food processing plants. At present some 15 different materials are being tested at various concentrations against 30 to 40 species of bacteria, including types known to be of importance as causes of spoilage and contamination in food industries.

RUBBER FACTS

*Hinge on Cost
Plus Performance*

PRESENT plants will probably produce at least 1,100,000 long tons of synthetic rubber in 1946. They cost 750 million dollars to build. That is an investment of approximately \$700 for each ton of annual production. If amortized over 20 years with 3 percent interest charged on capital investment, these plants would show a capital cost of just over four cents per pound of synthetic at the start, shading down to nothing in 20 years. Thus, at the projected selling price of the product of 16 cents per pound under peace-time conditions, the amount available for raw materials, repairs, overhead, and selling costs will start at around 12 cents per pound of product and increase year by year as the capital is written off. Yet, that's only one way of cal-

Ingenious New Technical Methods

To Help You with Your Reconversion
Problems



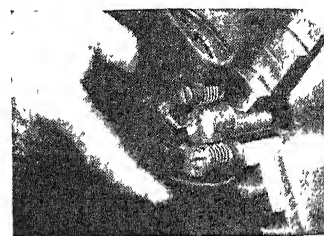
New Comparator Gage Saves Time — Gives 6 Inspections in One!

Even the most inexperienced operator can obtain accurate inspection of externally threaded parts, with the Limitrol Comparator Gage—in many instances, increasing the rate of inspection as much as 400%! The Limitrol, proved in hundreds of war plants, permits 6 visual checks in one: pitch diameter, lead, taper, out-of-roundness, angle, and straightness. Its use reduces inspection and production costs, cuts scrap waste while increasing speeds of operation. If a part passes the Limitrol, it will assemble accurately.

Graduated dials are furnished as standard equipment. These dials are graduated in increments which approximate .0005 inch when the magnification is 250 to 1, and serve as a guide in determining just how far over or under the limits the part might be.

Another "help on the job" is chewing gum. Chewing seems to make work go easier, time go faster. Good chewing gum is available, but there's still a shortage. That's why we at Wrigley wish we could make Wrigley's Spearmint now, to help increase the available supply. You may be sure we will, just as soon as sugar restrictions are lifted. Meanwhile, chew any good available brand, because it's the chewing that really does you good.

You can get complete information from
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Detroit 20, Michigan



Hand Model used for
"in process" gaging



AA-51

culating. But with butadiene from petroleum at six to seven cents per pound, synthetics appear competitive with natural rubber. Now, call in the politicians.

Reports from experts who have recently returned from careful examination of German synthetic rubber plants and plans, place the hurriedly constructed American industry well ahead of the older German one in quality of product, efficiency, and production.

For many important uses, rubber processors believe the various synthetics can never be displaced by plantation rubber, even at ruinous sacrifice prices. In other applications, the future surely holds great

promise for mixtures of synthetic and natural rubbers, also practically regardless of price. In still other applications the natural product will hold its place, according to informed opinion, even though it should cost 10 cents or so per pound more than its synthetic competitors—an unlikely situation. In the first class fall many uses embraced in the category of mechanical rubber goods and solvent hose. Tires seem probable members of the second class although various parts of tires for different services will fall into both the second and third of these classes. Side walls of balloon tires will require natural rubber for best service. —The Chemical Digest.

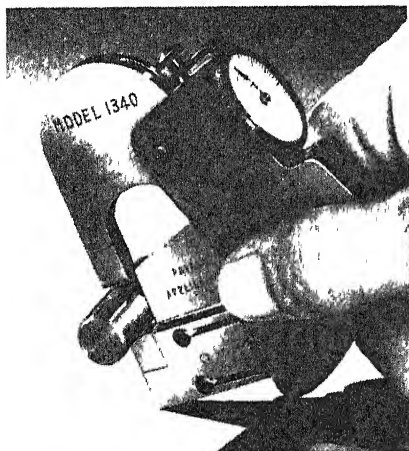
New Products and Processes

DIMENSIONAL VARIATIONS

*Measured Visually
With Snap-Gage*

FATIGUE and differences in the sensory perceptions of the operators are practically eliminated as sources of error with a recently introduced visual-indicating snap-gage. Dimensional variations are read directly in calibrations of .0001 inch on a dial with an .008 inch range.

Operation of the gage, manufactured by the Federal Products Corporation, is based on a flexible lower anvil which transfers the dimensional variation of



Snap-gage substitutes vision for touch

the workpiece to the dial indicator. Both anvils are tungsten carbide tipped and an insulating finger grip is provided to prevent heat transfers from the user's hand.

SILICONE VARNISH

*Gives New Advantages
In Electrical Insulation*

A NEW SILICONE varnish known as DC 996, enables all types of electrical shops to realize the new advantage of silicone insulation. Among those advantages are greater protection against failure due to sustained overloads; greatly increased service life of electrical insulation; higher permissible operating and ambient temperatures; increased protection against excessive moisture even after prolonged exposure to elevated temperatures; the elimination of fire hazards resulting from the failure of conventional electrical insulation; and increased power output per unit weight.

Electrical equipment wound with silicone insulating materials and sealed by impregnating with DC 996 will have the high order of thermal stability and the retention of waterproofness char-

acteristic of silicone insulation. Silicone insulating materials impregnated and bonded with DC 993 can be cured at temperatures obtainable in ovens now used for curing organic varnishes.

Another advantage of this new silicone varnish is that electrical equipment can be baked fully assembled without damaging the commutators or the slip rings.

POWERED COAL

*Made by "Puffing",
Meets Turbine Needs*

SIMILAR to the "puffing" of cereals, a new method of pulverizing and drying coal operates on the continuous explosion principle, and involves no moving parts. By simply allowing the coal to pass through a nozzle with steam or air, a high degree of pulverization is obtained with upper pressures of less than 100 pounds per square inch, and with moderate steam temperatures. It is reported that compressed air produces equally effective pulverization, without the necessity of heating the air.

The principle of the pulverizer depends on the steam or air entering the minute pores of the coal so that when the coal passes almost instantaneously through the nozzle—thus greatly reducing the outside pressure—the gas trapped in the pores expands and powders the coal. Drying, accomplished simultaneously with pulverization, results in dry powder; fineness of pulverization depends upon pressure drop and the ratio of gas flow to solid flow.

The process appears to be particularly well adapted to the preparation of coal for burning in the open-cycle gas turbine. In this application, the coal must be put under pressure and the air for pulverizing would be obtained from an auxiliary compressor which would take its air from the discharge of the main compressor. The pulverizing air would then serve as primary air to convey the pulverized coal into the chamber. Another application may be the utilization of large tonnages of wet coal fines which are now useless because their excess moisture makes it impossible to burn them in conventional equipment. The "coal atomizer" has demonstrated ability to dry and pulverize this material satisfactorily.

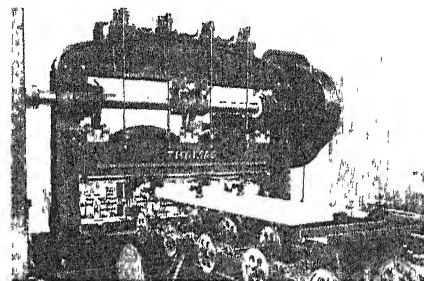
EDGER

*Prepares Plates Quickly
For Automatic Welding*

SUBSTANTIALLY reducing the time required for side edging or trimming of plates preparatory to their being automatically welded, a new trimmer has

been perfected which simultaneously trims both side edges in one pass.

The Thomas plate edger, made by Thomas Machine Manufacturing Company, shears the material rather than planes it. The shear cut, in addition to being more rapid, results in a tighter, more accurate joint between two plates than is obtained by any other production method, according to the manufacturer. Two major operational factors assure this result: First, the plate is held perfectly flat while under the shear blades. Thus mill wave, which is present in the majority of plates, is



Shear cutting gives accurate edges

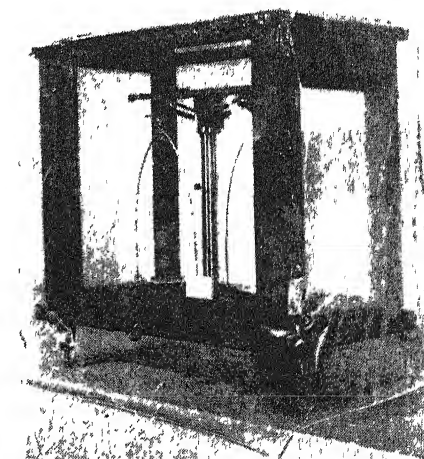
eliminated. Second, the plate is carried through the entire shearing cycle in the same relative position. In consequence, finished plates are removed from the machine with edges parallel within extremely close tolerances, ideal for automatic welding.

The plate edger may be operated by one man, and a high degree of skill is not necessary. In edging the larger and heavier plates, however, it is economical to utilize a helper for loading and unloading. Tool set-up or change may be accomplished by the operator with a wrench and a simple measuring tool.

TRANSPARENT ENVELOPE

*Protects Sensitive
Precision Instruments*

PROTECTION and preservation of valuable precision instruments, vital to accurate performance, is an industrial "must." To insure the precise functioning of delicate parts, instruments must be guarded from dust, lint, fumes, and moisture. For this reason, many makers and users of precision instruments



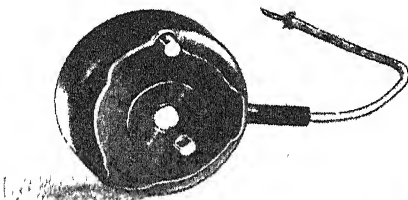
Flexible cover shields delicate scales

have called on the Resistoflex Corporation to "tailor" compar cases or covers, which completely enclose a wide variety of delicate instruments. A vinyl resin derivative, compar shuts out all harmful particles that might interfere with precise performance and preserves the most intricate of working parts. The covers, specially prepared to specifications, retain their transparency, flexibility, and immunity to air-borne dangers throughout an almost unlimited service life.

ROTARY SOLENOID

Has Many Industrial Uses

DEVELOPED and manufactured for use in bomb release mechanisms, a rotary solenoid is applicable to many controls in the aviation, automotive, railway, shipping, communication, and other fields where direct current is available. Known as "Ledex," these rotary solenoids are smaller in diameter than a man's pocket watch and only about twice as thick. Proportionately, they deliver many times the power of conventional solenoids. When the magnet



Solenoid is jar-proof and powerful

is energized by an electric current, a torsional power of the rotating member in excess of four inch-pounds is produced.

Besides saving space due to its compactness, the Ledex solenoid meets government requirements of immunity to accidental operation through shocks. This jar-proof feature is one of the advantages which especially commended the solenoid to aircraft engineers.

WHEEL DRESSER

Contains Over Five Carats of Diamonds

Just introduced by Industrial Abrasives, Inc., for the metal, ceramic, plastics, glass, and related trades, a new dressing tool, the Super-Cut Circle Set, is especially designed to fulfill the need for a sturdy, efficient, economical abrasive wheel dresser that is built for rugged service on jobs where fast dressing and long life is expected.

Some of the features of the new circle set are listed as follows. The new tool consists of only three parts, the circle set insert, impregnated with diamonds, 1/8 inch deep and 1/8 inch wide, the holder, and one set screw. The insert contains over five carats of specially selected diamonds, uniformly distributed; in case of accident or abuse, only part of the tool is damaged or destroyed instead of an expensive single point diamond. As the

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top layer of diamonds wears down, other diamonds are uncovered and come into cutting position so that, at all times, several diamond points are simultaneously in contact with the grinding wheel

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FOR USE in semi-hazardous jobs such as spot welding, light grinding, and woodworking, a plastics eye shield, weighing less than one ounce, has



Shield does not interfere with glasses; is quickly replaceable

been developed by Willson Products, Inc.

A feature of the FeatherSpec, as it is known, is the one-piece plastics lens, gripped tightly in a suspension-lock frame, but interchangeable or replaceable in ten seconds. A slight pull releases the lens from the grooved metal frame and makes it possible to substitute a green lens for a clear lens if the work involves glare.

The new shield can be worn over special prescription lenses with complete comfort and gives added protection to those workers who wear glasses. Only one size is needed to fit any type face because the new nose rest, which is part of the lens, simplifies the job of proper fit.

DEW-POINT RECORDER

Uses Photocell to Detect Moisture Film

CLOSER control of the effects of water vapor in air or other gaseous mixtures is afforded by a new dew-point recorder now offered by Surface Combustion. The recorder is especially applicable for furnaces utilizing prepared gas atmospheres, or wherever dehydrated air or a gas mixture of controlled moisture content is desirable, as in the chemical and food processing industries, drug preparation, and so on.

The recorder can provide a virtually continuous record of humidity within a temperature range of from minus 70 to plus 60 degrees, Fahrenheit. More precise and more frequent adjustments of the various constituent gases in the atmosphere can thus be made to compensate for differences in humidity. Or if humidity control of

the air or gaseous atmosphere is used, permanent information concerning its dew point is provided.

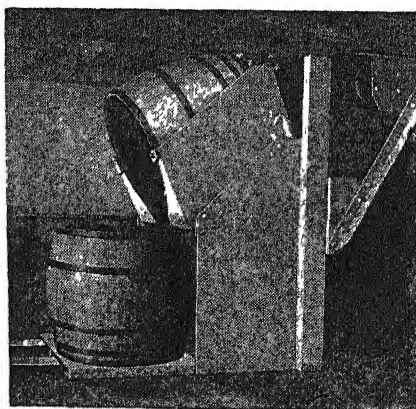
The recorder applies the principle of the dew-point cup, which has long been used in its original form for determining the humidity of air and other gaseous mixtures. Its operation is therefore independent of the nature or composition of the gases making up the atmosphere.

The principal units of the recorder are a dew-point cup with mirrored surface which can be refrigerated at varying temperatures, a thermocouple which is connected to a recording potentiometer, and the refrigerating unit with its associated circulating system. In operation, a stream of the furnace gas, after filtering, is directed against the mirrored surface of the dew-point cup, while refrigerant is circulated within the cup. As the temperature of the refrigerant drops, which in turn decreases the temperature of the mirror, a film forms on the surface when the dew-point temperature of the gas is reached. As soon as the film forms upon the mirror, it intercepts a light beam which has been directed upon the mirror and which is reflected on a photoelectric cell. When this takes place the cell alters the flow of current which in turn shuts off the flow of refrigerant around the mirror, at the same time making an instantaneous point record of that temperature on the recorder chart. This operation is continuously repeated at three minute intervals so that the series of instantaneous recordings forms a virtually continuous "line."

HEAVY VATS

Handled with Trucks And Tilting Device

IN THE packing industry, hams are cured in large open-top wooden vats containing a brine solution which must be changed at intervals. Formerly done by hand, the operation was slow and costly—the filled vats weigh 1600 pounds—and dangerous for men because packing house floors generally are wet and slippery. To make present-day mechanization of packing plants more effective, a vat-dumping unit was designed to elevate and empty the filled



Manpower is replaced by electricity for tilting and moving large vats

vats within a few seconds, eliminating hazards and delays that formerly slowed the entire curing line.

In operation, the loaded vat is transported by means of a fork-type truck and placed in a steel cradle. The cradle is centered in a steel framework to which it is pivoted at its forward end. The cradle with its load is tilted by means of gears and an electric motor. Brine and hams are discharged into another vat placed on a pallet of timbers, so that it may be readily lifted and transported by means of the fork truck.

Heavy loads are thus transferred so quickly and safely that the system, developed in coordination with Elwell-Parker Electric Company, will probably find application in other industries as well.

FAST RELAY

Has Sealed Moving Parts

SPEEDS up to 1000 per second are possible with a recently developed sealed-mechanism type relay. A glass envelope ensures reliability by protecting all moving parts from moisture, dust, or corrosive fumes, as shown in the cut-through illustration. Sensitivities down to ½ milli-watt and current ratings up to five amperes are available, while closing times may be reduced to one



Cutaway view shows compact design of relay mechanism sealed within

milli-second. Compact as well as fast, the Stevens-Arnold "Millisec" relay is three inches high with a 1½ inch base diameter for a 115 volt A.C. one-ampere rating unit.

NON-MINERAL OIL

Makes Cold Weather Starting Easy

HAVING unusual advantages over mineral oil, particularly for cold weather use, a new internal combustion engine lubricant is now being produced in commercial quantities. The lubricant can be manufactured to any desired viscosity and is wax-free. Pour-points vary from —30 to —80 degrees, Fahrenheit. Flash points range from 300 degrees, Fahrenheit, up and densities

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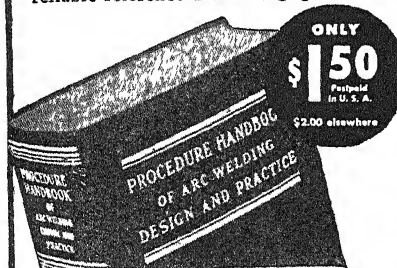
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approximate that of water. Carbon residue values are less than 0.01 percent, regardless of viscosity. The lubricant is characterized by low change of viscosity with change in temperature, having viscosity indices in the range of 140 to 160.

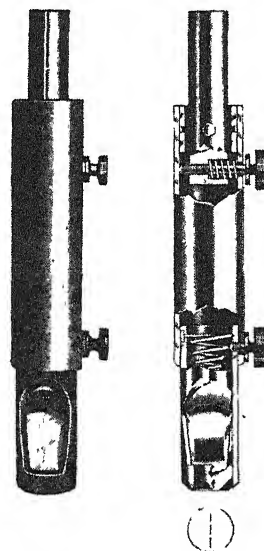
Developed by the Carbide and Carbon Chemicals Corporation, the new lubricant contains no petroleum oils and practically eliminates sludge and varnish formation in the engine. Wear of the moving parts is in line with wear experienced with ordinary mineral oils. Ease of starting in cold weather is an outstanding advantage.

CENTERING PROBLEMS

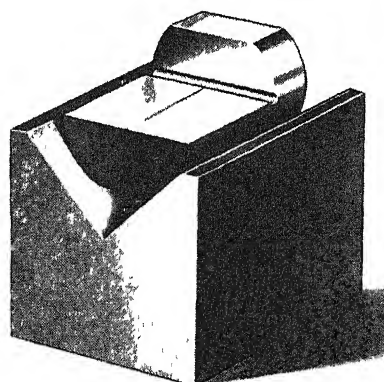
*Simplified by New
Optical Locating Device*

LOCATING layouts, work edges, lines, or punch marks to any revolving spindle axis is simplified with an optical device designed to be used on any vertical or horizontal spindle machine tool. Opti-Locator is easily fitted to standard collets, tapers, or other adapters and a fine threaded "line-up" screw compensates for any spindle run-out present in the machine, according to the Benton Company, its manufacturers.

Since the instrument provides magnified images, visual centering to an



Locator (above) has a line-up screw and focusing screw for setting, lens prism is spring mounted. Datum unit (below) gives center for vee block



Enlarged edition,
including statements by
the British and Canadian
governments

Atomic Energy

FOR MILITARY PURPOSES

*By Henry
De Wolf Smyth*

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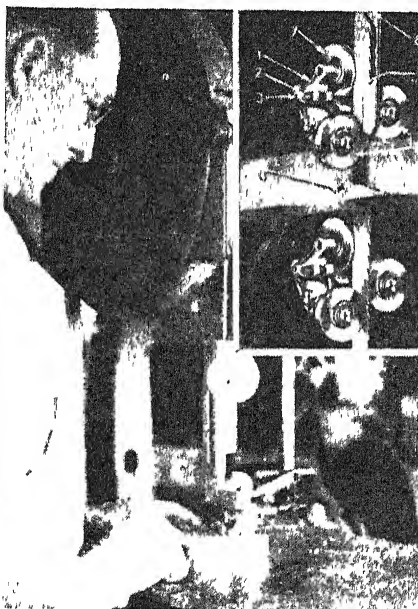
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Saw guide in use; inset shows details

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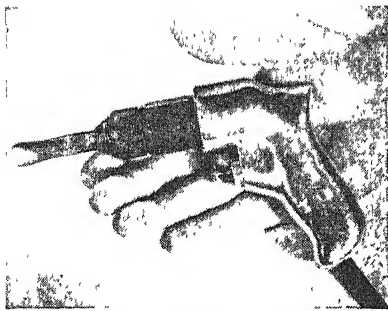
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Hammer features small size, high speed

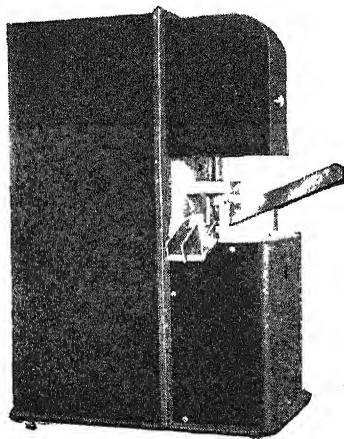
wide variety are available, are loaded in a quick-acting, ball-and-channel locking chuck. A quarter-turn of the knurled nose of the chuck locks or releases any of the tools. The "Bantam Bully" hammer has but only one moving part, the piston striking member, which is precision-fitted in a finely ground cylinder. Travel of the hammer piston is approximately $\frac{3}{8}$ inch and normally operates between 12,000 and 14,000 blows per minute, depending upon the trigger regulation and the air pressure available.

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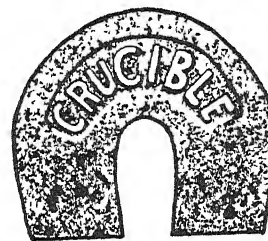
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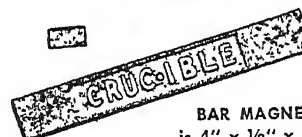
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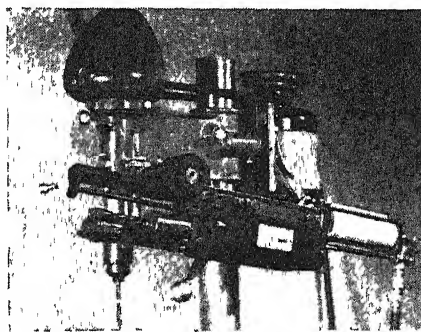
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Will Soon Be
Provided in Many Colors

THE LONG-FAMILIAR black rubber edging around automobile windows and windshields, and the stripping used as seals and bumpers for doors and hoods, is destined to give way in the future to a new plastics material which will not only do a better job of protection but which can be made in colors to match surrounding paint exactly or to provide contrast

The new material, an extruded "Vinylite" elastomeric plastics, has special heat-sealing properties for forming into continuous rings with no joints through which water may seep. Slipped around the window or windshield, it acts as a bumper between the glass and the metal frame, giving the glass a soft material on which to ride, preventing breakage of glass, and providing a seal for protection against the elements. The plastics gaskets are superior to natural rubber in resistance to oil, greases, gasoline, acids, alkalis, sunlight, and less affected by extremes in temperature.

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Has Many Uses
in Industry

EQUIPPED with a rubber cushion base and designed to withstand violent physical shocks, a high-impact filament lamp has been in service since early in the recent war. Except for a thick band of rubber surrounding the neck of the "HI's" bulb, the lamp closely resembles the ordinary household lamp. Remainder of the heat- and shock-resisting rubber skirted insert is firmly locked between the lamp's medium-



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Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious silent something which "whispers" to you from within.

Fundamental Laws of Nature

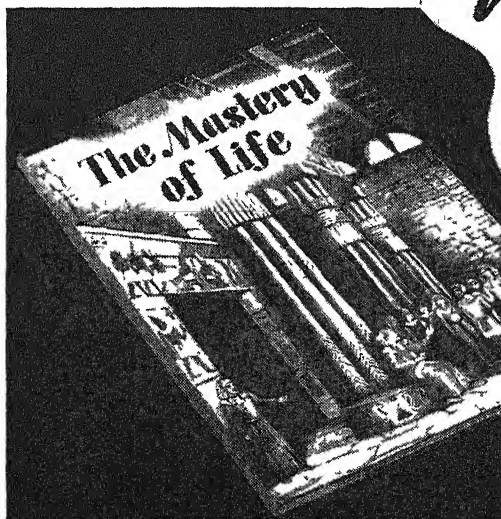
Your habits, accomplishments and weaknesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental

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screw brass base and the bulb's glass neck. The lamp, developed by General Electric, is rated at 50 watts and, because of its extra sturdy internal construction, might be said to "float" in rubber.

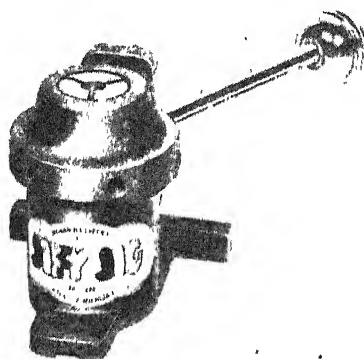
Laboratory tests show that the rubber-cushioned lamp can withstand shocks of 2000 foot-pounds and more. This is equivalent to the impact caused by a 400-pound weight dropping a distance of five feet to a solid object.

Applications for the new lamp are found in industries or equipments where lamps are subjected to unusual physical shock.

VERTICAL JIG

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BECAUSE a great number of shops had need for only a vertical set-up when using the "Jiffy Jig," described some months ago in these columns, Monarch Governor Company announces a simplified Model J-10A which provides for its use in this position only. Except for the bracket that allows for horizontal



Jig has only three parts and a lever

set-ups, this new model includes all of the features of the Model J-10 and is readily adapted to various machine tools for drilling, milling, grinding, boring, and so on. The chuck is designed to provide ample chip clearance and when the chuck is either open or closed, the collet has zero axial and rotary movements, giving positive axial and rotary dimensional control.

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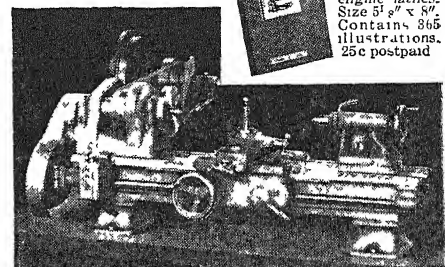
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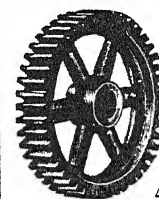
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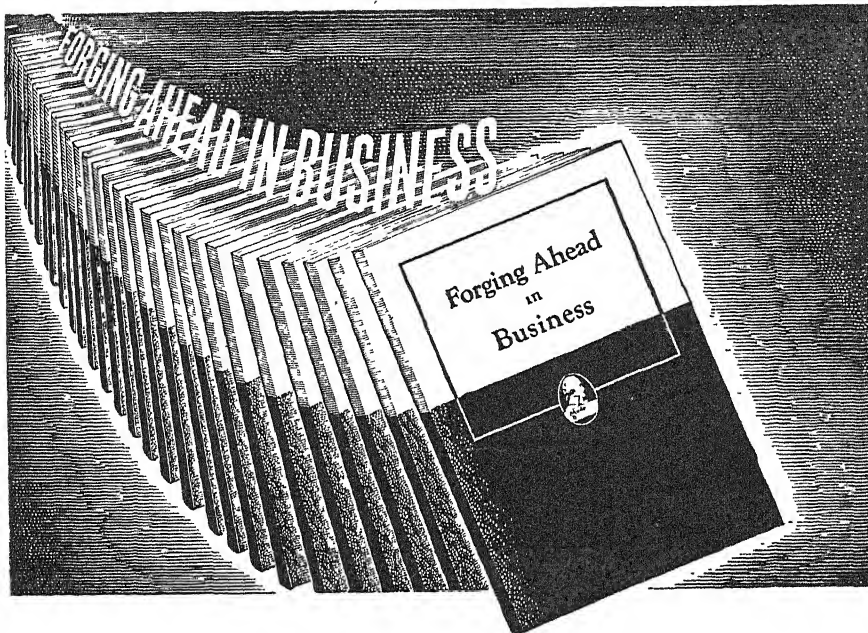
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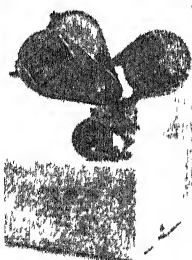
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Telescopes

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making"
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IF YOU are an amateur telescope maker, how many times have you had your whiskers rubbed a little backward by non-astronomical visitors who gratuitously assumed that you must have made your telescope from readymade parts which you had merely assembled, and that "Of course, you didn't make the 'glasses.'" Exercising noble self-restraint—for, after all, it must seem a bit fishy to the uninitiate—you modestly reply that you made the main mirror and most of the rest. Your visitor's eyebrows now go up and so does your stock. You then point out that making the mirror is really the central part of the fun, but that you had about as much fun in concocting the mounting out of various thises and thats which you adopted and adapted. By this time your visitor is on the way to being hooked as another addict of the hobby.

When it comes to using things originally intended for other purposes but kidnapped and re-adapted as parts of a telescope, and doing so neatly, the 10" instrument shown in Figure 1, made by Warner Williams, a Chicago sculptor and designer and connected with the Culver Military Academy at Culver, Indiana, has a high score. Examining the photograph:

The base is of concrete. Williams first modeled it smoothly in clay—to him as a sculptor a familiar medium—then cast a plaster mold of this model, and finally filled that mold with concrete.

The polar axis is a 6" artillery shell casing, and it is both clean and rugged—certainly won't shimmy.

The fork arms are made of the two

rear axle housings from a car; such parts are steady enough for a jolting car but require stiffening for a telescope jolted only by light breezes. It's a question of just how stiff you require. In this, a telescope is an extreme case.

The declination axis bearings are connecting-rod bearings from a car motor.

The two setting circles are meridian circles taken from geographical globes.

The finder is built around a mailing tube.

The main tube is sheet metal formed on a tinner's brake, and its open section is made of $\frac{1}{4}$ " water pipe.

The mirror cell is made from a motorcar brake drum.

The driving mechanism embodies a back gear ($\frac{1}{2}$ r.p.m.) motor unit such as are used for display tables, gears from a car generator, parts from a player piano and a carburetor. The drive is transmitted to the polar axis drum by means of an endless belt made from a steel tape "This type of drive," Williams writes, "has the distinct advantage that no special gears need be cut or purchased. The drive wheel can be turned up on a wood lathe to any needed size to give the proper ratio between either standard gears or available junk and the final pulley in the train."

"And thus," he continues, "after a long and fanatically joyful struggle, my telescope is finished and promises years of use and pleasure."

Williams once sculptured a life-sized plaster bas relief plaque of Foucault, illustrated and described in this department in December, 1943.

IN THE October, 1945, number of *The Journal of the Royal Astronomical Society of Canada*, 198 College St., Toronto, Ont., Canada, E. K. White, Chapman's Camp, British Columbia, well known to amateurs in this country, a correspondent of your scribe's, and whose telescope (Figure 2), has a surplus of mechanical, optical, and artistic sex appeal, has so cogently brought together various arguments for the long-focus Newtonian telescope that we reprint his entire article here, with courtesy credit to the periodical named.

Judging from casual comments heard, it is suspected that some Yank amateurs think the Royal Astronomical Society of Canada must be composed at least of professional astronomers who, being "royal," all wear crowns. It is, instead, an organization of amateurs—plain folks, uncrowned, unhaloed—like our own amateurs. Obviously, these Canadians are more enterprising than we Yanks, since they have had their amateur astronomical society for 56 years.

It includes 11 local city groups which meet regularly. Our long-projected American association still is a thing on paper, but, now that the war is over, it probably won't be long before Chailey Federer will be tearing around the terrain helping organize one as per pre-war plan. White's paper:

"This paper deals briefly with some advantages found by the writer in the construction and use of Newtonian reflectors with focal lengths about 12 times the aperture, over the more commonly known $f/8$ mirrors.

"In most articles dealing with the making of Newtonian reflectors the amateur is advised to choose a focal length about eight times the aperture of his mirror. Rev. W. F. A. Ellison says, 'I recommend $f/8$ because it combines the easiest figuring with capabilities for excellent performance' (see page 385 in 'Amateur Telescope Making'). Just what accuracy of figure is necessary in an $f/8$ mirror of (say) 8" aperture to give excellent performance? It is an accepted fact that a mirror will give perfect definition if its surface be figured to one quarter wavelength of sodium light, or about five millionths of one inch. It has been

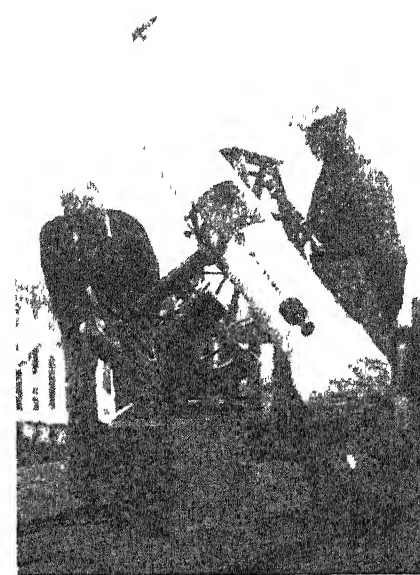


Figure 2: White's 9" $f/11$

shown by Mr. F. B. Wright (page 257 in 'A.T.M.') that an 8" diameter mirror of $f/8$ must have its surface within 33 percent of a perfect paraboloid to give excellent results.

"In the case of an 8" diameter mirror of $f/12$, Mr. Wright tells us that it can be finished spherical and still give fine definition, for a sphere and a parabolic surface of this dimension are very nearly coincidental. The allowable tolerance from a perfect paraboloid for an $f/12$, 8" mirror is 110 percent. Most opticians agree that it is less difficult to figure a spheroid than a paraboloid, and the former is most certainly easier to test by the well known Ronchi method (page 264 in 'A.T.M.'). Also there are no r^2/R zones to measure as with the paraboloid.

"The parabolizing of a mirror is necessary to correct the surface for the one aberration found in specula, name-

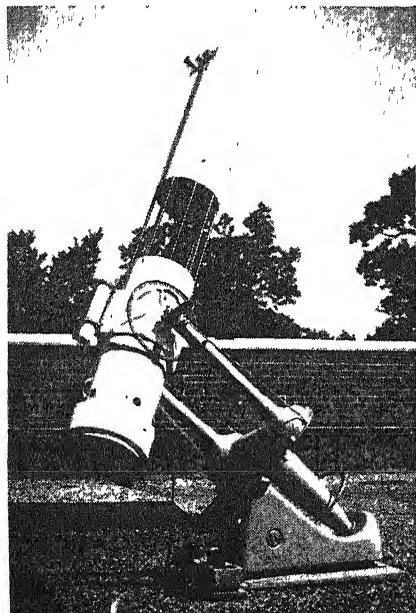


Figure 1: Williams' 10" telescope

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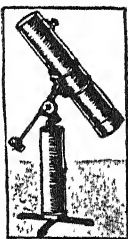
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ly, spherical aberration. In other words a spherical mirror of around $f/8$ proportions will not reflect the marginal and central rays of light from a star to the same focal plane. However, in small mirrors up to about 10" aperture and of $f/12$, this is not the case. The old masters, such as Herschel, With, and Lassell, who made their mirrors before Foucault's knife-edge test was known, realized that longer focal lengths enabled them to make better corrections on their mirrors, which also meant better performance. Thus we find that most of their mirrors were made to $f/10$ and higher, and many of these specula did give very excellent performance.

"Let us discuss further advantages of long-focus mirrors. It has already been shown that they are at least a little easier to finish, and I have found that an $f/12$ mirror 'a little off' will give better images than an $f/8$ of the same aperture which is about equally imperfect in figure. Turned edge cannot be tolerated in either mirror, but slight zonal errors are not at all serious in the longer focal length.

"Perhaps the most important advantage of long focus is that one can employ a smaller secondary mirror and thereby reduce light loss a little, and diffraction effects a great deal. In my opinion few amateurs realize the bad effects on stellar images a secondary mirror has when its minor axis much exceeds one sixth the diameter of the primary. One has only to place a cardboard disk about one quarter to one third the diameter of the main mirror on the secondary support directly in front of the flat or prism to see the bad effects it will have.

"For finest definition an elliptical secondary mirror that is really flat is superior to anything else.

"The more common types of eyepieces are designed to work best with a slender cone of reflected or refracted rays, and the $f/12$ mirror will give flatter and better fields with Huygenian and Ramsden oculars than will $f/8$ mirrors, which should really employ expensive achromatic eyepieces for best results. Also the $f/12$ mirror will enable one to obtain high magnification, should it be desired now and then, without seeking extremely short-focus oculars at high cost.

"Two further advantages of lesser importance are, first, changes of air temperature actually have little effect on the image quality as a result of temporary changes in the long-focus mirror's shape while in use, but such is hardly true with $f/8$ mirrors of plate glass. Secondly, many amateurs take photographs of the moon, using their reflectors as the camera. With focal lengths a little over 100" the image of the moon at the focal plane of the primary mirror is about 1" in diameter. This is large enough to record quite an abundance of detail on a plate or film, and bright enough for rapid exposures. With such a sizable image the use of an eyepiece may be dispensed with altogether. The writer has taken some fair lunar photographs with an 8 3/4", $f/12$ mirror on Panatomic film using exposures as short as one hun-

dreth second. These negatives can be enlarged to at least 8", and the resulting prints are quite sharp.

"It can be shown that the disadvantages of the long-focus Newtonian are few and not at all serious. Probably the outstanding one is that a longer tube will be necessary, which will require a well designed and rigidly built mounting, costing little more, however, than a good one for an $f/8$ mirror. Provided the instrument is permanently mounted out of doors, its shelter will also require to be a little larger. The eyepiece position will be somewhat higher, but a good step ladder will bring it within easy reach. These disadvantages will be found to be of little consequence where the mirror is not greater than eight or ten inches in diameter.

"While mentioning the longer tube, one may wonder if tube currents are increased, particularly when a solid metal tube is used. The writer has not found this to be the case with a 9" $f/11$ mirror mounted in a closed metal tube. ('Air Currents Within the Reflector Tube,' *Journal R.A.S.C.*, November 1943).

"The field of view will be smaller when using an $f/12$ mirror, yet with some Ramsden oculars of about 1" equivalent focal length, all of the moon's image can be seen in the field at one time with a mirror of about 100" focus.

"In conclusion, it might be of interest to mention the performance one may expect when using a good, long-focus mirror as compared to that of an $f/8$ mirror on different classes of celestial objects. With double stars there will be a marked improvement in the images of an $f/12$ mirror, and there will be less diffraction effect with bright stars. The images will be crisp even with high magnification (in good seeing), and quite comparable to those seen with a refractor. Nebulae and clusters will appear in the $f/12$ mirror much as through a refractor of equal size; a shorter focal length mirror would of course give brighter images of these objects, provided apertures were the same.

"With planetary and lunar detail the $f/12$ mirror comes into its own, and it is my opinion that such a good mirror will outperform any $f/8$ of the same aperture in this field. I have given an account of my observations of Saturn using a 9" $f/11$ mirror elsewhere ('Saturn with a Nine-inch Reflector,' *Sky & Telescope*, March 1945.)

"The writer hopes that amateurs who are contemplating the construction of a mirror will give the long focus some thought before deciding upon the usual $f/8$ focal ratio, and the tyro who may dread the difficult task of parabolizing cannot go far wrong in trying out a 6" spherical mirror of about 75" focal length."

HERE'S a good-news note from John W. Lovely, Secretary of the Springfield Telescope Makers, 27 Pearl St., Springfield, Vt.: "We at Stellafane are planning to have a full-scale convention this year on Saturday and Sunday, August third and fourth." More details when they become available.

Scientific American

Founded 1845

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Our Cover: Taking a sample of molten metal from a melt, for laboratory test, at the Geneva Steel Works operated by United States Steel Corporation. Steel's present status and possible future progress are detailed in the article starting on page 101.

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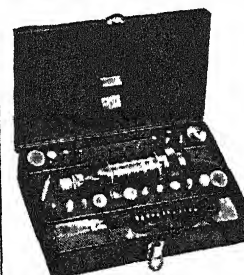
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50 Years Ago in . . .



(Condensed from Issues of March, 1896)

INVENTION — "In the line of new invention and discoveries, notwithstanding all that has been already achieved, there are, without doubt, as many brilliant successes lying before the inventors of the future as have been credited to the inventors of the past. The way is open to all."

FUEL — "A process has lately been brought out by Carl Wegener for utilizing powdered coal. The coal is fed into a hopper which is located in front of the furnace. At the bottom of the hopper is a grating, which can be agitated from 150 to 250 times to the minute, according to the rapidity of feed desired. The coal dust falls through into the bend of an air supply pipe, which enters the furnace at the top of the furnace door. As it falls into this pipe it is met by the induced draught and carried into the furnace."

X-RAYS — "The accompanying X-ray photograph of a hand is of especial interest as being the first photograph that we have seen that shows clearly the position of the veins in the



hand. The effect was produced by injecting a fluid in the hand of a corpse, thus making the veins opaque to X rays and enabling them to be photographed. . . . Another interesting development is the production of direct optical shadow effects on a disk charged with barium platino-cyanide. This is the fluorescent salt used by Roentgen in his first experiments."

SAWDUST GAS — "There are several large lumber mills in Deseronto, Canada, and the town is partially lighted by gas obtained from sawdust from them. The sawdust is charged in retorts which are heated by a wood fire. The gas from these retorts passes into a series of coils and thence into the purifiers, which are similar to those used for coal gas."

MOTOR-CAR TROUBLES — "A recent conviction for the illegal use of a horseless carriage has been obtained in England. The owners of the carriage were summoned for not carrying a flag in front of it."

FLYING — "Whoever has followed with attention the technical treatises on flying will have become convinced that human flight cannot be brought about by one single invention, but is proceeding toward its perfection by a gradual development; for only those trials have met with success which correspond with such a development. Formerly men sought to construct flying machines in a complete form, at once capable of solving the problem, but gradually the conviction came that our

physical and technical knowledge and our practical experiences were by far insufficient to overcome a mechanical task of such magnitude without more preliminaries." By Otto Lilienthal

GLASS — "A glass plate of different colors is formed by two or more layers of transparent or opaque glass cast upon each other so as to constitute a single plate upon which, by moulding or pressing, letters or designs of any shape or dimensions can be represented."

IRON AND STEEL — "There are seventy-four iron and steel bridge building works in the United States, twenty-two locomotive works, thirty-six iron and steel shipbuilding yards, sixty-four completed car axle works and two building, 112 completed car wheel works and one partly erected, and 112 car building works."

LATHES — "Nothing delights the heart of the true mechanic more than the examination of a perfect lathe, unless, indeed, it may be the actual possession of one. There are other machines more wonderful, and capable of performing intricate work, and imitating manual operations with remarkable fidelity and great rapidity. But for the lathe, such machines could not exist. The lathe may, therefore, be regarded as the progenitor of all machines. Having a perfect lathe, the machinist can produce anything required in the line of machinery or tools."

ABRASIVE — "Emery is one of the few valuable rocks not yet produced in important quantities in America. Large amounts are yearly brought from Turkey and the Greek Islands. . . . Many new uses will doubtless be found for emery; but probably it can take no more important place in industry than that of the emery wheel and the emery millstone."

100 Years Ago in . . .



(Condensed from Issues of March, 1846)

LUMBER — "One would think that such an everlasting and universal slashing as is going on in the woods would very soon exhaust all the pine timber. . . . Meanwhile large fortunes will be amassed to be squandered by posterity after the sources as well as the results of their fathers' wealth are dissipated."

TELEGRAPH — "Morse's magnetic telegraph has been adopted in Austria in preference to all others. It is evidently the most simple and easy of management"

CARPETS — "M Bigelow, an ingenious American artisan, has invented a power loom for weaving grain carpets, which is already in use by the Lowell Company, who have set 50 looms in motion, and expended nearly \$100,000 in this branch of manufacture."

PRAIRIE CAR — "There are few plans of enterprise, now in progress, to which more importance attaches, or which excite more interest, than that of navigating the extensive prairies by steam-power, and with carriages capable of accommodating 100 passengers, besides twelve to twenty tons of merchandise."

IRON — "There are twenty-three furnaces now in full blast in Pennsylvania, and six more are in progress and nearly completed. When these are put in operation, the quantity of iron produced per week, is expected to amount, in the aggregate, to 1,750 tons per week."



Wave Makers

"A leaping trout awakens the still pool to life in waves that move in silent rhythm."

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Previews of the Industrial Horizon

TO OFFSET PRODUCTION COSTS

IF EVER the industrial engineering fraternity as a whole faced a challenge, it does today. Wages are up, labor's interest in its job seems to be decreasing, raw materials are increasing in price—all along the line costs soar while strikes and other impediments bring production down.

Here, then, is the challenge to engineers. In the vaunted efficiency of American industry, still more efficient techniques must be evolved. Production methods must be devised that will offset overall increases in cost. There are many approaches, and wise management is investigating them all as rapidly as ingenuity will permit. Two units must be produced where only one was produced before. Time and motion study, redesign of equipment for faster production, use of machinery that is more efficient, and—not the least of the engineer's problems—employee relations, are all a part of the present picture.

Worn threadbare by now is the statement that American industry has learned many production lessons from war-necessitated speed-ups. But such work was done under forced draft, with little or no thought given to cost. Now the scene is changing. Competition is back. Labor is striking for what it considers to be its "rights," regardless of consequences to the country as a whole. Wages will go still higher for awhile. Inflation will continue—to an extent that only time will determine. Through it all, industrial management remains saddled with the multi-sided job of carrying on the American way of doing things. And management must rely on engineering brains for the ways and means.

Here are a few examples—presented for purposes of thought stimulation rather than for operating detail—of some of the things that can be done. Air-operated fixtures in one machine shop have increased production in some operations more than 100 percent; new honing techniques speed removal of metal from stock by six to eight times while resulting in precision of high magnitude; incentive systems, whereby the worker's pay is increased in proportion to his productivity, are coming into wider use, formerly gloomy shops and foundries are being cleaned up, made brighter, with good psychological effect on labor; decentralization of industry is helping to get factories nearer to sources of raw materials and assembly lines closer to markets.

By means such as these, and many others, American industry can overcome the handicaps of mounting costs. And, showing the way, will be the industrial engineer who has the vision to view the picture as a whole without losing sight of its component parts.

HIGH PRESSURE STEAM

AS AN EXAMPLE of what can be done when necessity presses is the buzz-bomb launching system perfected by Babcock and Wilcox. The equipment uses steam at 1200 pounds per square inch pressure and can handle steam at the rate of 3,000,000 pounds per hour. This potential power is controlled by a valve having an opening and closing time of three one-hundredths of a second and remaining open for eight tenths of a second. In this short space of time, the equipment develops a peak of 25,000 horsepower.

Here is something for steam engineers to conjure with. The system may never be used to launch buzz bombs against an enemy, but it has many implications for peace-time applications.

DOWN ON THE FARM

FARMS IN the United States are growing fewer in number but larger in size, and it's all because of mechanization. Tractors, bulldozers, and combines have changed the entire agricultural horizon in recent years and will probably continue to do so for some time to come.

By A. P. Peck

Down in the wheat and rice farms of the Texas Panhandle, in the cotton plantations of the south, up in the farms of Michigan and Wisconsin, even in the smaller units of the east, the trend is definite and encouraging. With mechanization, much of the arduous and distasteful labor of the farm is eliminated. Operating costs per acre go down. Farm operation becomes more attractive. And the entire nation will benefit by decreasing costs of production.

While looking at the farm picture, let's glance at the farmer's wife. According to a study made by the Kansas State College, there is a tremendous pent-up demand for electrical equipment in the farm kitchen, running water in the bathroom, fresh paint on the house and farm buildings, and linoleum on the floor. The survey further shows that two thirds of those planning purchases want to pay cash. Of the remainder, only 8 percent are planning on installment purchases. The average farmer surveyed expects to spend about \$1000 in the next two years on household and farm equipment.

IN THE MOVIES

IN RECENT years, industry has learned much about the value of moving pictures for training purposes, public relations, and employee education. A few specialized producers have attempted to fill the demand. Now Hollywood has cast an appraising eye on the industrial field and is starting to do something about it. Without plumping too strongly for Hollywood's blood, thunder, and sex technique, it is obvious that the moguls of moviedom could contribute greatly to the technical improvement of industrial films of all types.

ON THE RAILS

AN ORDER has just been placed with Pullman Standard by the Baltimore and Ohio Railroad Company for two eight-car streamlined all-coach trains. The Illinois Central, the Missouri Pacific, and the St. Louis-San Francisco have been conducting surveys to determine what their passengers want in the way of service, speed, and equipment.

These are all steps in the right direction. The railroads still have an odorous past history to live down. A few crack trains and sporadic surveys will not do it. Service must be improved all along the line. Schedules must be speeded up and maintained. Railroad personnel must be snapped out of its war-time attitude of "the public be damned" and re-educated to the fact that the public maintains the railroads. Only then will the railroads start once more toward the goal of reclaiming business from other forms of transportation. The technological means are available. Let the railroads make the most of them.

FOR FUTURE REFERENCE

THE ELECTRICAL utility industry, according to the Federal Power Commission, has "advanced significantly toward a degree of financial soundness". . . Reynolds Metals Company, with new acquisitions, will have sufficient capacity to produce as much aluminum as was necessary to fill pre-war demands; after filling their own requirements, they will sell alumina at cost plus 6 percent. . . Glass-reinforced plastics can compete with metals in many uses. . . Surface coatings for wood are being perfected that will prevent the growth of infectious fungi and bacteria; uses are indicated in hospitals, schools, theaters, and other public buildings.



Courtesy Timken Roller Bearing Company

Seamless steel tubing—seen here emerging from a reheating furnace during manufacture—offers economies in many uses by eliminating machining and promises to give strong competition to tubing of other metals

METALS IN INDUSTRY

Steel Fights Back

By FRED P. PETERS

Editor-in-Chief, Materials & Methods

A Basic Industrial Material, Steel is Assured a Continuance of Its Top Position by New Production Methods, by Specifications Tailored to Definite Industrial Needs, and by Its Inherently Adaptable Qualities. War-Time "N.E." Steels have Proved Themselves and Are Here to Stay

AMID the forecasts of steel's decline as the champion among modern engineering materials, and of the dawn of a "light-metal era" or a "plastics age," certain fundamental factors stand out: (1) even on a volume basis the production of steel dwarfs the combined production capacity of light metals and plastics; (2) steel will be required in large amounts to equip and supply the industries producing and fabricating light metals and plastics; (3) on a price basis, which inevitably determines the disposition of the tonnage business, steel is the over-

whelming favorite; and (4) the steel industry is developing its own special answers to the light weight, corrosion resistance, or beauty of the more glamorous materials.

In short, steel is and will long continue to be our basic industrial metal. During the war the steel industry developed stronger alloy steels; stainless steels that are cheaper to fabricate; steels with excellent resistance to the high temperatures encountered in gas turbines, jet engines, and turbosuperchargers; and coated and clad steels that combine the basic qualities of

steel with the special surface properties of other materials. The industry's metallurgists and engineers worked out new fields and types of applications; taught users how to employ steel more economically; and formulated specifications that enable consumers to specify and order steel to the best advantage of the user.

Continued study of the physical chemistry of steel making, contributing to better regulation of metallurgical reactions, slag composition, temperature, and deoxidation, have led to greater refinement of produc-

tion practice and control of the end product. Many alloy steels formerly made in limited quantities in an electric furnace can now be made in huge open hearth heats. This means a lower price to the buyer. Consumers also find available "intensified" steels, whose hardenability has been greatly enhanced by addition of boron. Bessemer steel has seemed to be passing out of the picture, but better practices, improved standards, and elimination of rule-of-thumb methods of manufacture have made it a formidable rival of open hearth steel for many applications.

Speedy deposition of a thin phosphate film on sheet and strip steel found many applications in wartime and other new coatings are now helping to make steel more useful. Pickling processes have been developed, including continuous pickling which is faster and more efficient, while deep drawing of steel for cartridge cases, to supplant scarce brass, has taught many lessons. Improved automotive springs, used in military vehicles, will result in better peace-time equipment and another special steel, developed for landing mats, may now be adapted to preventing soil erosion. Other recent improvements include abrasion-resisting grips for conveyor belts, special galvanized sheet steel for air-conditioning ducts, and an enameling stock for signs and household goods that requires no ground coat.

ALLOY STEELS—The outstanding broad trend in ferrous materials engineering is the war-impelled and

still increasing emphasis on alloy steels. These seem to be the steel industry's major strategical answer to any implied threat from light metals, carbide tool materials, plastics, plywoods, and so on. New alloy stainless and tool steels have met the need for improved strength to weight relationships; better resistance to heat, corrosion, and wear; and various specialized properties.

The development and specification of alloy steels have been carried forward with special attention to working properties and costs. The N.E.—National Emergency—steels have demonstrated their usefulness, and some are here to stay. Steel specifications based on hardenability—the "H" series—have been formulated and steels of various types have been produced specifically for easier welding and adaptability to welded structures. Machinability factors—with particular emphasis on behavior with carbide tooling, with new lubricants, and after heat-treatment—have also been the subject of much attention.

The N.E. steels of the war are unique in that they are not a trademarked brand of any one company but rather the products of the steel industry as a whole. Developed in 1942, by engineers associated with the American Iron and Steel Institute in co-operation with the Society of Automotive Engineers and other groups, they were devised to save critical alloying elements such as nickel, chromium, and molybdenum. In the N.E. steels the amounts of alloying elements are much reduced in percentages and they often de-

pend on three or more alloying elements where two were used before. Again, they take advantage of the "residual" alloys present in ordinary scrap, residuals which increase in alloying percentages as the years go by.

The importance of these steels may be gaged by the fact that, during 1944, 36 percent of all alloy steel production was of the N.E. type. This, of course, does not necessarily reflect the popularity of the N.E.'s, since war-time conditions compelled their use in many applications. The real test will come when steel is plentiful and consumers can choose freely the specifications they want.

Advances in the application of individual steels, and in methods and bases for specifying, have also been made. One of the foremost of these has been the promulgation by the American Iron and Steel Institute of the "H" steels specifications. It is now possible to specify engineering alloy steels of all standard types as to hardenability limits rather than on the former chemical-composition basis only.

By using "H" steel specifications, the steel user does not encounter the occasional off-hardenability heats that are common when steel is ordered to chemical-composition specifications only. On the new basis the chemistry may vary slightly but the hardenability—of greater practical importance—will be within the specified ranges. This will not only enormously simplify the user's heat-treating problem but will also aid the producer in fulfilling the specification requirements.

The "H" steels, identified by the letter "H" following the usual numerical designation—8730H, NE 9440H, and so on—are produced to conform to specific end-quench hardenability limits, which are based on hardenability bands for each steel as tentatively established by A.I.S.I. and S.A.E. committees. For users to whom hardenability problems are critical, the "H" steels are a definite solution.

EXTREME TEMPERATURE STEELS—

Successful production of turbo-superchargers, gas turbines, and jet-propulsion units depended on finding materials that would withstand the 1200 to 1500 degrees, Fahrenheit, at which many parts of such equipment must run continuously. Usual heat-resistant materials either scale badly or lack strength or stability under load at these temperatures.

The materials developed and used overcame these limitations individually, and by careful application of

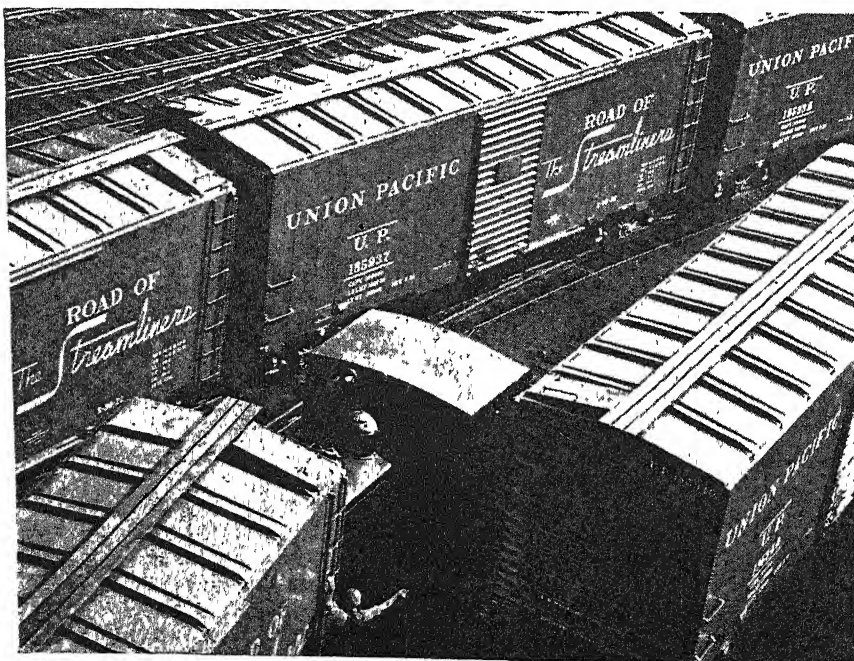
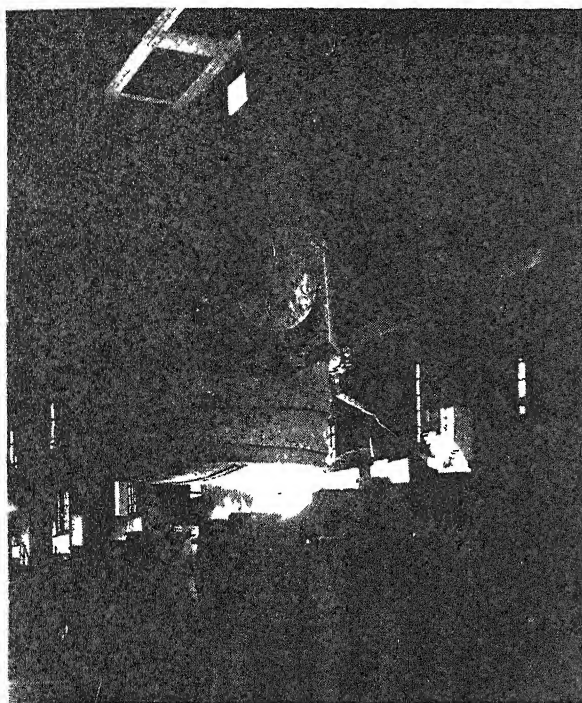


Photo by Bethlehem Steel Company

High-tensile, low-alloy steel plus welded construction save 8300 pounds on each of these 50-ton boxcars. Use of the "right" steel for the job is important



Large open hearths are now being used to meet tonnage demands for special alloy steels once limited in quantity by electric furnace production

Courtesy American Rolling Mill Company

the previously available materials where they could be used and of the newer "super" materials—often expensive or difficult to fabricate—for only the most severe-service areas or parts, the problem was satisfactorily solved. Research, however, goes on for even better materials to permit important improvements in the thermal efficiency of gas turbines and like devices.

Many of the new materials are nickel-base or cobalt-base alloys containing chromium and tungsten, titanium, and/or molybdenum. But some of the most useful are classed as steels. Thus, for impellers in aircraft jet-engines, a new steel containing 16 percent chromium, 25 percent nickel, 6 percent molybdenum, and 0.08 percent carbon was employed. Another modified stainless steel—19 percent chromium, 9 percent nickel, plus tungsten and molybdenum—was fabricated from plate and forgings into parts to operate at 1100 to 1300 degrees, Fahrenheit, in marine gas turbines.

A new steel, introduced during the past year and specially developed to have superlative mechanical properties at sub-zero temperatures, contains 8 to 10 percent nickel and less than 0.12 percent carbon. Capable of giving Charpy impact values of 25 foot pounds at minus 320 degrees, Fahrenheit, its minimum tensile properties in the form of normalized tubing—at room temperature—are given as 80,000 pounds per square inch ultimate strength, 50,000 pounds per square inch yield strength, and 20 percent elongation in two inches.

This cold-resistant steel is reported as being applicable to low-

temperature work in place of the conventional 18/8 stainless steel tubing, and it appears to have especially interesting possibilities for oil refineries and the chemical industry. Corrosion resistance, one of its chief features, suggests logical fields of use where a combination of resistance to chemical attack and to low-temperature embrittlement is necessary.

LOW-ALLOY STEELS—Builders of all types of transportation equipment, striving for the lightest possible weight consistent with safety and cost considerations, are showing interest in two new low-alloy high-strength steels that have recently entered the specifications.

One of these—Aldecor—is of the traditional class of high-yield-strength, low-alloy steels, with corrosion-resistance superior to copper-bearing steel, and good formability and weldability as-rolled. Its distinguishing feature is an imposing array of alloying elements, the composition ranges being 0.25-1.5 percent chromium, 0.25-1.5 percent nickel, 0.07-0.6 percent molybdenum, 0.08-0.75 percent copper, 0.07-0.18 percent phosphorus, 0.50 percent maximum manganese, and 0.14 percent maximum carbon. Not only does the amount of each constituent serve a special purpose with respect to strength, corrosion resistance, or processing behavior but the whole composition will provide a suitable use for the quantities of tri-alloy scrap which will continue to come back to the steel mills for the next few years.

Another new low-alloy steel is "J-alloy," which is produced in

three carbon-content grades, low-carbon for high ductility, formability, and weldability in the as-rolled condition; high-carbon for abrasion-resistant applications; and medium carbon for low-alloy shafting and other uses. The medium and high-carbon grades benefit from heat treatment and in this respect J-alloy differs from most of the other low-alloy steels, which are conventionally produced for use in the as-rolled state. J-alloy is described as also retaining good toughness down to sub-zero temperatures

OTHER STEELS—In the tool steel field, the tungsten type high-speed steels have recovered much of the ground lost to the high-molybdenum high-speed steels—such as 6 percent tungsten, 6 percent molybdenum compositions—but the latter are "here to stay" in considerable amounts, like many other worthy war-time "substitutes."

A new free-machining tool steel, now on the market, is described as having 25 to 200 percent faster machinability than the usual tool steels and to surpass the ordinary tool steel specifications in many ways. It is an oil-hardening—to 65 Rockwell—very slightly distorting steel, with good impact and transverse rupture strength, and exceptional wear resistance. Suggested uses are in cold-work dies, hard machined parts, bushings, and so on.

An important trend is evidenced toward the use of tool steel tubing in place of bored-out hard steel rods for many parts. Tool steel tubing often saves much time and expense in producing a hard steel ring, bushing, arbor, annular die, liner, sleeve, or similar part, and may also simplify the problem of achieving full hardness where desired without excessive distortion.

Development of a new fine-grained titanium-bearing steel—christened T1-Namel—gives manufacturers of vitreous-enameled products a base stock on which they can apply white or light-colored single cover-coat enamels without prior applications of a ground coat. The titanium, present in the steel in proportion to the carbon content, reduces or eliminates pitting, black specks, and blisters when the steel is enameled.

In general, steels may lose some end-use applications to other materials, but it is plain that the industry is highly active. Steel is developing its own answers to the challenge from without, but in any case is certain to find wide markets in machinery and equipment to manufacture the new competitive materials.

Detecting the Invisible

Sub-Surface Flaws are Revealed and Their Location and Size Determined by Non-Destructive Inspection with Supersonic Frequencies Formerly Used to Trace Submarines. Electronic Mine-Detectors, Also War Products, May be Ideal for Scouting Pipe and Cable Laying Projects

By JOHN MARKUS

Associate Editor, *Electronics*

ELECTRONIC detecting devices, relieved of their war-time concern with land-mine hazards and anti-submarine patrol, are now being adopted by the industrial world. These "electronic eyes," capable of probing for flaws in the depths of solid objects or of sounding the surface of the earth for unseen pipelines, cables, and other obstacles to excavation, hold promise of wide utility; they detect hidden flaws without destroying the part under test, and they can be mounted on a vehicle to scout underground installations with surprising speed and accuracy.

FLAW DETECTION — Electronic flaw detectors, for non-destructive inspection of castings, forgings, and similar items, employ supersonic frequencies—the sonar principle—used during the war for detecting

and following submarines. Ranging between one million and twelve million cycles per second, these frequencies are too high for detection by the human ear. Moreover, supersonic waves travel best in solid or liquid materials and weaken rapidly in air; in this respect they differ from radio waves, in the same range of frequencies, which travel best in air and on the surfaces of metals.

In use, the instruments send supersonic pulses into the material under test and measure the time it takes the pulses to travel through the material, reflect from the opposite side or from a defect, and return to the point of origin. Flaws and defects can be detected up to ten feet away from the point of application of the small search unit. This unit, consisting of a piezoelectric quartz crystal, not only transmits the supersonic pulse into the material but also receives it after reflection. A film of oil or other liquid, to aid the transfer of the pulses, is applied between the crystal and the material.

Electrical energy, supplied to the crystal for conversion into mechanical energy, is produced by an electronic generator and synchronizer that provides three different output pulses 60 times a second. These pulses actuate other electronic circuits that cause an intermittent horizontal deflection of an electron beam on the screen of a cathode-ray tube. The resultant broken line appearing on the face of the tube thus provides electronically controlled distance markers that can be adjusted to represent any desired length, in inches, within the material under test. Distortions of the line appear when a pulse reflects from a defect in the material,

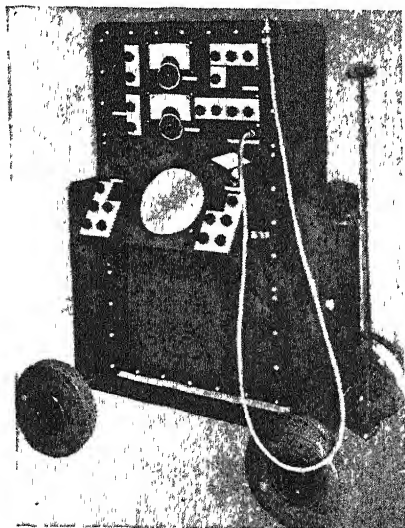
and the markers indicate the defect's distance from the point of application of the crystal.

Invented by Dr. Floyd A. Firestone, the flaw detector is manufactured by Sperry Products, Inc., and has been applied so far mainly to testing of metals. Both plastics and liquids, however, conduct supersonic waves at the frequencies utilized in the instrument and are therefore adaptable to this method of testing or measuring. Variations in materials, in wavelengths of sound, and in the size of the defects to be located, made a wide range of testing frequencies mandatory for general industrial use. Adjustment of only six knobs changes the testing frequency and for ordinary testing an operator may be trained in two weeks.

The maximum penetration distance of the supersonic pulse de-

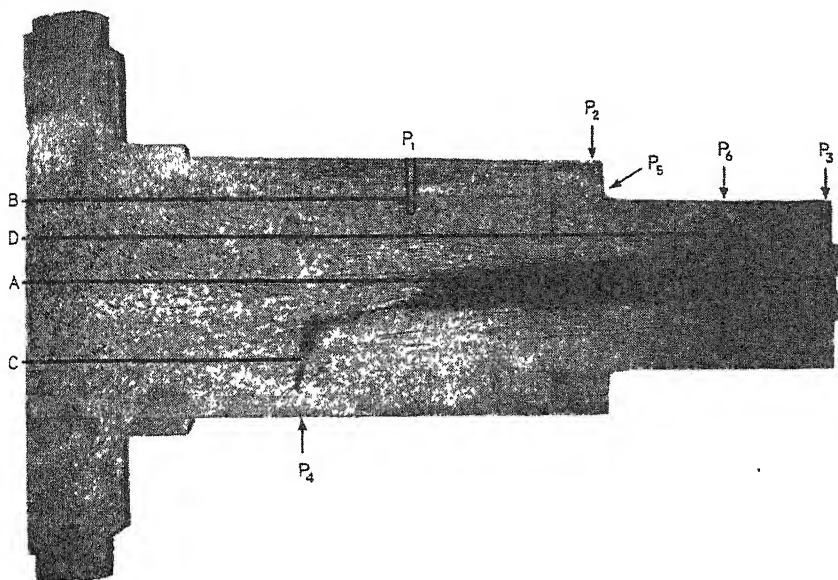


Portable mine detector spots metallic or non-metallic sub-surface objects; headphones and meter signal a pickup



Sperry type supersonic Reflectoscope; quartz-crystal search unit is seen on end of cable; cathode-ray tube screen is large circular area at center left

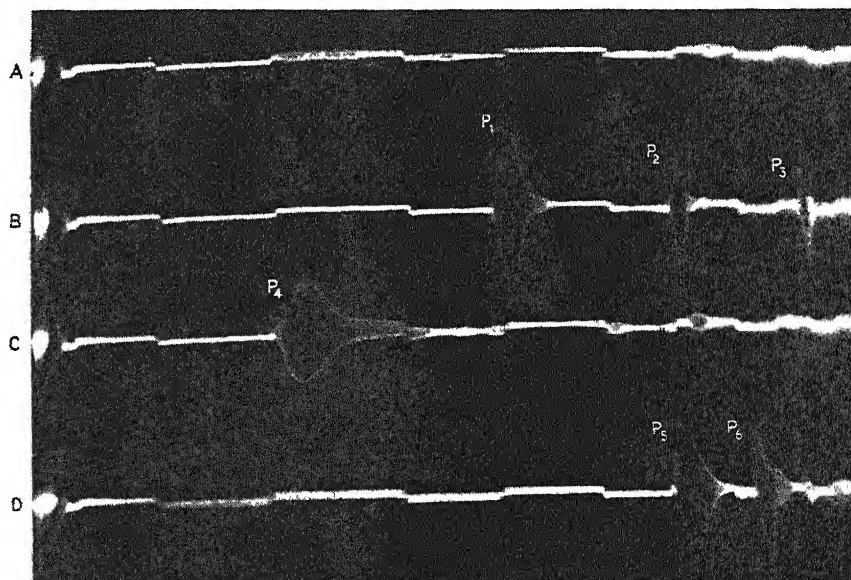
pends upon the material. Steel and aluminum permit relatively deep penetration while such metals as lead and copper are fairly resistant to penetration. Large grain sizes and small discontinuities make it difficult to test long distances in any material when these discontinuities are of the same magnitude or larger than the supersonic wavelength being used.



Line traces on cathode-ray screen (below) are logged to locate distance of flow indications— P_1 , P_2 , P_3 , P_4 , P_5 , and P_6 —from points A, B, C, and D where search unit was applied. Corresponding lettering and lines on sectioned axle (above) show sources of indications and sound paths.

Although the size of the distortion on the cathode-ray tube screen and the size of the defect are only roughly proportional, the area of a large flaw may be plotted by moving the search crystal over the testing surface and noting the indications on the cathode-ray tube. Approximate sizes of small flaws may be determined by decreasing the testing frequency in steps until the supersonic wavelength approaches the major dimension of the defect and the indication disappears. Often, considerable information about defects may be deduced from the shape of the distortions appearing on the screen. Hydrogen ruptures, coring, inclusions, fatigue cracks, shrinkage cracks, stringers, piping, segregations, and laminations are some of the defects in metal that may be found with the supersonic detector. The thickness of a material can also be measured when one side is inaccessible. Defective bonds between similar as well as dissimilar metals can be found, and the soundness of many welds can be determined.

Pictures of the cathode-ray tube screen show the supersonic pulse reflections obtained by different positions of the searching unit. The cause of the reflections and the corresponding positions of the crystal search unit on the part being tested, in this case an axle, are readily identified in the cross-section. The reflection P_1 was due to a 1/16 inch diameter, two-inch deep hole drilled for comparison purposes. The reflected pulses P_4 and P_5 were obtained from the transverse defects, and the diminution of the end of the axle produced reflection P_6 .



The search unit crystal used was one inch square.

The minimum area of the discontinuity required to give an indication depends on its distance from the surface being tested and the homogeneity of the material. In aluminum, for example, a void with surface dimensions of 0.125 by 0.002 inch will cause a reflection when this discontinuity is two inches from the searching unit, and a 5/32-inch diameter defect will give a reflection when the flaw is 10 feet from the crystal.

Supersonic testing should find wide application in industry, since axles, shafts, and other objects having one end accessible may be inspected for fatigue cracks while still assembled. The flaw need not extend to the surface, nor is it necessary to remove wheels or other parts

from the axle or shaft. In the past, fatigue cracks, even though they extended to the surface, could be found only by disassembling the part and examining it closely. The advantages offered by supersonic testing, including high accuracy and ease of operation, will make the process an important addition to the non-destructive testing field for many materials.

UNDERGROUND—Crews surveying routes for proposed underground pipelines or cables have long needed a metal detector whose sensing elements could be supported ahead of a vehicle running at a reasonable speed. Such a device would prevent subsequent interference with existing installations or other objects in the path of the digger. Military demands for a vehicular-mounted mine-detector spurred the development of an electronic unit of this type that not only gives a visual

and aural indication of buried metal but also stops the vehicle automatically and almost instantly by means of electrical controls.

The mine-detector consists of an oscillator-energized transmitting coil and a receiving coil connected to an amplifier. In the absence of mines or other metal objects, interaction between the two coils is nullified. Approaching a metal object, either buried or above ground, upsets the delicate electrical balance and energizes electronic circuits controlling brake and clutch electromagnets.

The sensitive coils are carried ahead of the vehicle on a boom. Since the coil's elevation above ground would vary too much in rough terrain if a rigid attachment were used, most of the boom weight is balanced by an adjustable torsion-

spring system, and wheels support the boom a fixed distance above the ground. The use of plywood tubing and wooden blocks for the boom, and non-metallic wheels, prevents electromagnetic interference with the coils. The automatic stop system employs a combination of springs and trigger mechanisms working almost instantaneously on both the foot brake and the clutch, and is actuated by the mine signal itself.

Fail-safe features, necessary to prevent missing an object because of failure of the equipment are so designed that any breakdowns of the circuit automatically change the output signal and trip the brake and clutch mechanism to stop the vehicle. Meters on the dash of the vehicle would further indicate circuit trouble.

Before starting operation, the electronic detector circuit is balanced by means of manual controls and a water-proof cover is placed over the control panel of the oscillator-amplifier box. Thereafter, the operator uses a simple control box mounted on the steering column. This control box incorporates a meter which at all times enables the operator to know if the circuit is still in good balance, and also indicates the presence of mines. A switch is available to disengage the automatic equipment when automatic stopping is not desired and various tell-tale and warning lights show when the equipment is turned on and whether all the switches and circuits are in operating condition.

The vehicular mine detector was developed by Electro-Mechanical Research, Inc., for the Engineer Board, the development agency for the Corps of Engineers, United States Army.

PORTABLE DETECTOR — A new portable one-man mine detector that responds to buried mines or other metallic or non-metallic objects was developed during the war as a counter-measure for non-metallic anti-tank mines, and also has promising peace-time industrial applications.

This small detector consists primarily of a 300-megacycle vacuum-tube oscillator and antenna system mounted in an exploring head that is carried over the ground being searched. Indications are both aural —through headphones— and by deviations of a meter mounted on the carrying handle. Capable of indicating the presence of a standard American anti-tank mine at depths up to five inches, depending upon soil conditions, the detector is limited by water-soaked soils to a range of one inch or less. Extremely

dry soils mask the presence of non-metallic mines while allowing normal detection of metal objects.

The detector responds to changes in the average dielectric characteristics of the soil over which it is carried. Non-uniformities in the ground must generally be at least five inches long, two inches wide, and one inch deep to be detectable. This means, of course, that indications will be obtained from stones, tree roots, and air pockets in the soil, but a trained operator can learn to distinguish the characteristic signals resulting from each type of object. Roots, for instance, could be followed for some distance along the ground, whereas the response for a mine would be localized.

The total weight of the detector, including batteries, is 23 pounds. In use, the operator moves the detector head from side to side, advancing approximately one foot per sweep while holding the unit somewhere between two and five inches above ground. Over normal soils, metallic mines make the audible signal weaker while non-metallic mines make it louder. In quiet locations a resonator on the unit eliminates the need for headphones.

Industrially, this detector set or its modifications may be used to detect the presence of metallic masses of finite dimensions in non-metallic objects, while discriminating against

objects of smaller size. Voids or discontinuities in plastics objects can be detected with other modifications of the detector.

When adjusted off resonance, detection of personnel or vehicles in motion at ranges up to 100 feet is possible. In such an application the detector might be valuable for intrusion detection systems, particularly where ambient light or noise prevent the use of audio or photoelectric systems. Further suggestions propose its application as a safety control for machines where space limitations or other conditions prevent use of conventional safety equipment.

Initial research and development work was carried out by the RCA Victor Division and RCA Laboratories. The work was directed by the War Department Engineer Board and the National Defense Research Committee.

It is interesting to note that the electronic developments described here supplement rather than replace such other detecting methods as X-rays, radar, vibration-testing for flaws, and magnetic testing with such cathode-ray instruments as the DuMont Cyclograph. Each method has its own advantages and its own group of applications to which it is best suited for economic, engineering, efficiency, speed, or other reasons.



CRYSTALS

*May Be Used in
Push-Button Receivers*

QUARTZ crystals for radio equipment are usually individually processed to increase the activity of vibration. As a result, each plate exhibits certain individual characteristics that are different from similar plates of equal dimensions.

In a new technique developed by Philco engineers, as many as 100 plates can be processed as a group to final square-edge dimensions within 0.0002 inch tolerance. All the blanks for a particular frequency are then exactly the same at the finishing stage. This minimizes the tendency to lap or etch beyond the desired thickness for that frequency and avoids most of the failures encountered in temperature cycling.

Such a mass-production technique may lead to the use of the quartz wafers in home push-button radio receivers to eliminate drifting away from the station frequency. Each desired frequency would have one crystal, so that a ten-station push-button set would use ten crystals.

In the past, the amount of hand work by skilled operators brought the cost of ten crystals too high to be incorporated in any but a high-priced receiver.

ARC CONTROL

*Made Automatic By
Use of Thyratrons*

WHILE THE charge in an arc furnace is melting down, the electrode must be lowered to maintain the arc. When melting scrap falls against the electrode and causes a short-circuit, withdrawal becomes necessary. Normal consumption of the graphite in the electrode also requires that corresponding adjustment be made.

An electronic unit which gives a wide range of speed and quick response in control of the motor drive which accomplishes all these regulations has been announced by Westinghouse Electric Corporation. The system works by varying the armature voltage of a constant-field motor with thyatron tubes to produce the required speed of electrode motion.

Plastics In 1946

WHAT PART will plastics play in the civilian products due to appear on the market during 1946? This question is in the minds of the public; the product manufacturer, the plastics processor—molder, fabricator, and extruder, and the plastics materials manufacturer.

The answer would seem to be that within six months' time present troubles due to material shortages and scarcity of processing equip-

Finding its Best Market in a Diversified Group of Other Industries, the Plastics Industry Looks Forward to a Busy Year. Production, Still Somewhat Limited by Materials and Equipment Shortages, is Expected to Smooth Out Soon. Will All-Plastics Cars be Forthcoming Eventually?

By CHARLES A. BRESKIN

Editor, *Modern Plastics*

Butyrate

	Ounces
8 rack supports	0 78
1 door knob	0 95
1 evaporator door knob	0 11
1 nameplate	0 25
	2 09

Polystyrene

1 escutcheon and button for lower front	0 67
1 door front and liner for evaporator	9 35
1 Crisper front	6 63

Laminated phenolic

1 control wheel and gear	6 88
4 breaker strips	14 85
1 inner door panel	57 67
4 food compartment supports	1 62

Cellulose acetate

Strike and ctr rail gaskets	0 14
Total plastic used, 6 lb, 39 oz	

ment will be at least partly in the past. Normal full capacity operations should have become well organized and production should be steaming along at a furious pace with customers fairly well assured of a date upon which their orders for various plastics parts will be delivered.

All this, of course, is predicated on the ability of American business to reconvert its plant facilities and to settle its many labor and management difficulties, upon a quick return to normal political relations between nations, and upon a fairly rapid adjustment to economic stability in the devastated nations. If these disturbing elements are alleviated, it is reasonable to expect that the plastics industry will be on

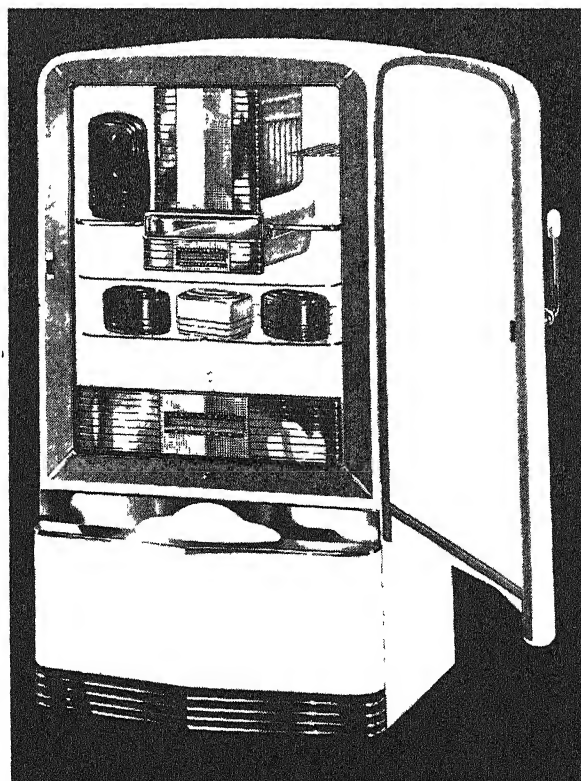
its way to surpassing the 161-percent increase predicted for it by the Committee for Economic Development.

OTHER INDUSTRIES—Judging by every known survey released thus far, this 161-percent increase is not as astounding as it would seem at first reading. Consumers in the United States are going to be in the market for more materials in 1946 than in any time in the nation's history. Because the plastics industry is so largely concerned with supplying parts and finished items to other industries—consumer durable goods,

automobile, construction, transportation, textile, paint and varnish industries, and the electronics fields—expansion of these industries means, of necessity, an even greater increase in the volume of plastics products.

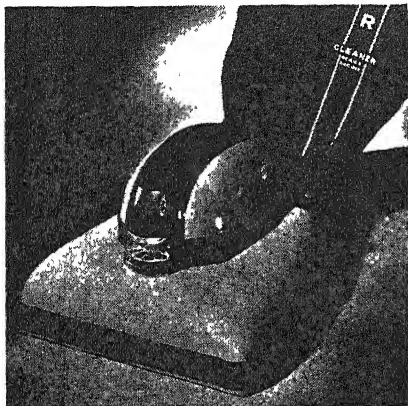
Take the metal-working industries as illustrative of the increased demands that may be expected by the plastics industry during 1946. According to a survey of the 55 metal-working industries which was released by the Civilian Production Administration in late 1945, the shipments of these industries by the middle of 1946 will be three times

Innovations in modern refrigerators (right), such as Crispers and transparent doors, require various types of plastics in substantial quantities. Table (left) indicates amount of plastics used in a representative domestic unit



Courtesy Westinghouse Electric Corp.

the average 1939 rate. Of course, it would not be surprising if the metals trade runs ahead of many other manufacturing enterprises in increased production in the first post-war years. Its production lines were almost completely changed over to special war items and the demand for its products, such as refrigerators, automobiles, machinery, and so on,



Courtesy Durez Plastics & Chemicals, Inc.
Many new vacuum cleaners employ some plastics parts, but amounts vary

has grown so tremendously that it may take a long time to satisfy all the potential customers.

However, this unusually high business potential is of great importance to the plastics industry because metals trades are among its best customers. Furthermore, plastics were just beginning to get a foothold in this field before the war. If the metals trades increase their production two and a half or three times in the next six months, it is to be assumed that their demand will be for even more than two and a half or three times the plastics they used in 1939.

Since it is impossible to detail every particular field where plastics are used, a few of the most representative industries have been selected to indicate the potential demand and supply possibilities for plastics.

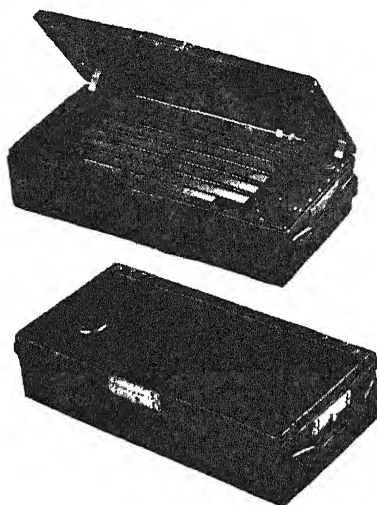
AUTOMOTIVE PLASTICS—In automobiles there is little evidence to indicate that more plastics will be used per car by any of the old companies for the 1946 passenger car than were used in the 1942 model; the 1946 model being, for the most part, a reproduction of the last pre-war model. But what of the 1947 models? Motor company officials are extremely reticent in discussing their plans, but it is certain that plastics will not fade out of the picture as some quarters have predicted.

As far as thermosetting applications are concerned, these have been well established for years. While certain poor applications may be

corrected through redesign or the use of another type of raw material, there should be little change in this picture. Instead there may be an advance in the use of thermosetting materials if certain types of laminations fulfill the role anticipated for them.

The thermoplastic materials may find increased use in a number of parts of the 1947 automobile. Take, for example, its application in doughnut-shaped white sidewall disks which fit over tires and give the appearance of white sidewalls while protecting the tire from scuffing. And there is the huge field of car upholstery.

It has been estimated that at least 50 percent of all war-time truck-



Courtesy Emerson Radio & Phonograph Corp.
Sturdy and attractive, hand radio case is made of cellulose acetate butyrate

type vehicles requiring coated fabric seat covering used vinyl or coated cloth. Although synthetic rubber is now becoming available, plastics materials manufacturers expect to capture at least half of this market. And at five square yards for the average truck, this is a substantial market. If upholstery for station wagons and convertibles is counted in, the market for vinyls mounts tremendously.

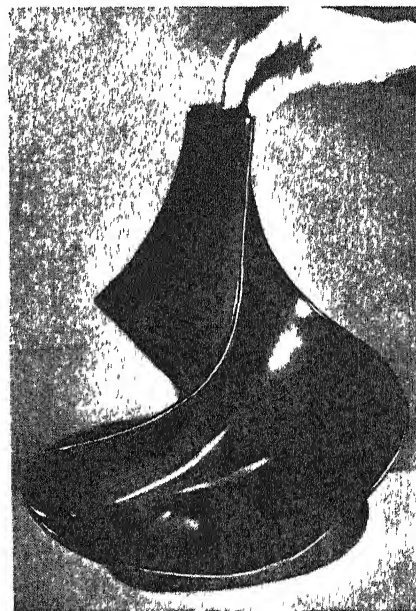
Perhaps some of the greatest curiosity regarding new cars centers around the projected automobiles with plastics bodies. Two come from California—one, called the Bobbi-Kar, is to weigh less than 600 pounds—the other, the Californian, is to have but three wheels. A third model is the one being designed for Graham-Paige by William Stout, famous airplane designer.

DOMESTIC GOODS—Washing machine agitators of plastics, just beginning to come into use when the war broke out, still appear to be the most important item in washers,

with respect to the plastics industry. Housewives were said to like them because of their color and because they did not corrode as metal units sometimes do as a result of the action of the soap.

However, because the cost of the plastic agitator is about 25 percent higher than that of a similar unit made of aluminum, the plastics industry expects to get only a part of the business in the older type machines. But even on the laundry units that lack this three to seven pound plastics part, there will be a few molded accessories such as the knobs.

A breakdown of the plastics parts on a typical refrigerator, which was supplied by a representative company, shows that a surprising amount of this material is used. The totals are somewhat of an increase over pre-war units where there were few Crisper fronts and where a transparent door and liner for the evaporator was the exception. Then, too, increasing use is being made of



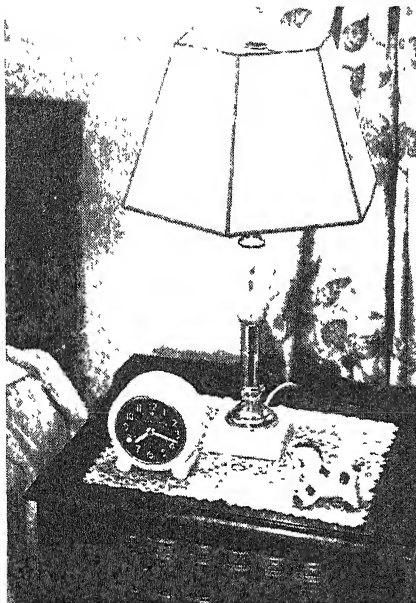
Courtesy Bakelite Corporation

A plastics washing machine agitator, largest pre-war item in this field

laminates, particularly for the inner door panel. These last three plastics applications are appearing in more and more of the well-known models.

OTHER USES—Juke boxes, coin machines, and vending machines all represent a most interesting field for plastics. Surveys have shown an estimated increase in this industry of 110 percent for 1947 which is greater than the increase for any other industry save only plastics, rayon, and transportation.

There are two branches to this field; amusement machines and vending machines. Chief users of plastics up to now are the nickel



Courtesy General Electric Company
Plastics cases will probably be used on about half of the new alarm clocks

phonographs or juke boxes, the principal plastics used is cast phenolic. Its high color and forming qualities are desirable characteristics for this application.

Other plastics used in minor accessory parts today, perhaps in major elements later on, are polystyrene, cellulose acetate tubing, vinyl resin, and laminated parts. Whatever the material, it should be a type that will not scratch nor shrink. And it must lend itself to the music box's

requirement of bright colors and resistance to rough-house treatment

Today the demand for all types of coin machines is so great that the manufacturers are using any material available which means that, save for juke boxes, only the old type metal box is in production. Plans now on the drawing board, however, call for the use of quantities of plastics

Probably none of its customers put so much pressure on the plastics industry as did radio manufacturers immediately following V-J Day. The reason, of course, was the great rush to be first on the market. The many uses of plastics in the radio field were fully discussed in the February Scientific American.

Different radio manufacturers use different amounts of plastics, and it is only possible to take a mean average RCA reports that their pre-war plastics cabinet required two pounds, four ounces; a new model will need twice that amount Stewart-Warner states that the average weight of plastics in one of their models be from 2½ to 3¼ pounds or about ¼ pound more than the pre-war model.

In general, all indications are that for the plastics industry the ending of the war opened the way to an even greater expansion in material manufacturing and processing facilities than it experienced during the war years.

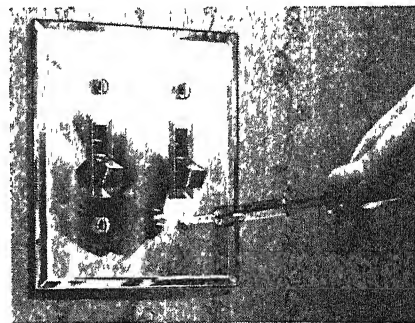
the molding of the two parts of the laminated diaphragm case are cut into pieces three feet long. Each ply is laid at a 90-degree angle to the one below. These laid-up panels are preformed under pressure, the pre-forming plates being heated to a temperature that will just soften the resin. This treatment reduces the bulk factor and produces a laminated sheet that can be easily handled.

Blanks about the size and shape of the mold cavity are cut from the sheets and the load carefully weighed. These blanks are then loaded in the mold cavity Both parts are molded under relatively high molding pressures in a flash-type compression mold

PLASTICS SCREWS

*Hold Mirrored Switch
Plates in Place*

EVER notice how incongruous are the dark metal screws which hold mirrored switch plates in position? Now, screws as light as the switch plate itself have been put on the market by the Haring Switch Plate Company. These transparent screws,



Transparent screws for switch plates

injection molded of Tenite by Plastics Division, S. S. White Dental Manufacturing Company, are lighter in weight than their metal counterparts and are said to exert less pressure during installation, thereby reducing the chances of the mirror being chipped or marred.

SCOURING CLOTH

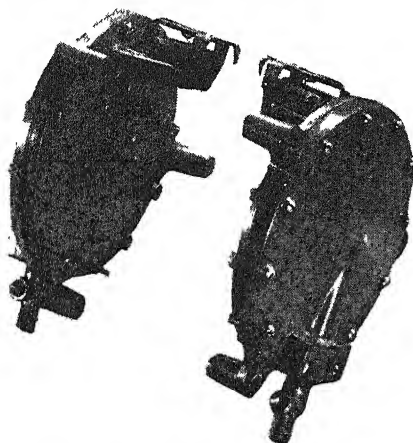
*Uses Plastics Beads as
Abrasive; Stays Clean*

LATEST plastics household help is a Plaskon coated scouring cloth in which the plastics is sprayed onto a terry cloth base to form little beads on the surface. These beads provide the abrasive necessary for cleaning. Advantages of this new Downy Products Company scouring pad are: no metal splinters to hurt the hands, absence of all film after the pot is cleaned, no breaking off of parts of the cloth, no absorption by the pad of dirt or food particles.

FIRE CONTROL

*System Uses
Plastics Parts*

RECENTLY developed rate-of-rise fire alarm, fire control, and fire extinguishing systems depend for much of their success on the diaphragm cases molded of Avtex by the Hood Rubber Company



Front and rear views of plastic-molded diaphragm case used in new heat-actuated fire alarm system

Essentially, each system consists of one or more heat-actuated devices, or heat detectors, fastened at intervals to the ceiling and connected to the diaphragm case in a release mechanism by means of air-tight tubing. Heat from a fire causes the small amount of air that is trapped in the heat-actuated device nearest the flame to expand. In turn, this pressure is conveyed through the air tubing to the release mechanism where it moves a sensitive metallic diaphragm which starts the fire protection apparatus working

The diaphragm case and the metallic diaphragm are the heart of the mechanism upon which the operation of these systems depends. Consequently, it is of utmost importance that the two molded parts which comprise the case be precise in their measurements. Otherwise, the sensitive diaphragm, which is held in place between the halves of the housing, may be thrown out of line so that the actuating air impulse will not blow against it with the necessary force.

The sheets of material selected for

A New Eye for Industry

Millionth of a Second X-Ray Equipment Has Been Built Which Can be Directly Applied to Great Numbers of Practical Industrial Uses. Its Ability to Watch High-Speed Machinery in Motion May Practically Influence Present-Day Machine Design, Use, and Maintenance Techniques

By EDWIN LAIRD CADY

JUST ARRIVING on the industrial market is an X-ray device which can look through an inch of steel, stop motion—in a photographic sense—of the fastest moving mechanisms ever built, and produce pictures which will tell just what each hidden machine part is doing.

Designed originally for basic research, this millionth of a second X-ray machine is moving straight into the practical end of factory operation. It can give the right answers to many problems about which management men have been guessing. It can save a tremendous amount of time along the production line. Laboratory men may use it also, but there is too long a line-up of tasks on the shop floor for such a device to remain simply a research tool.

PEERING THROUGH MACHINES—

Typical of what this machine can do is the experience of a large manufacturer in New England. In this shop is an automatic machine which, once it gets going, will turn out millions of brass parts without stopping. The trouble always was that when setting up the machine the

ejection mechanism would jam. Nearly all of the working parts of this mechanism are hidden, shielded by steel housings. The set-up men had to make their adjustments by guess and by "sense" and by "feel." With good luck the machine might be set up in an hour. With bad luck it could take days. There seemed to be no dependable "average set-up time" which could be predicted when planning production runs.

One of the millionth of a second X-ray machines was available to the plant laboratory. Someone thought of bringing it to the automatic machine. This did not present any difficulties; the X-ray machine is mounted on wheels and can be transported as easily as any floor type, long framed shop crane.

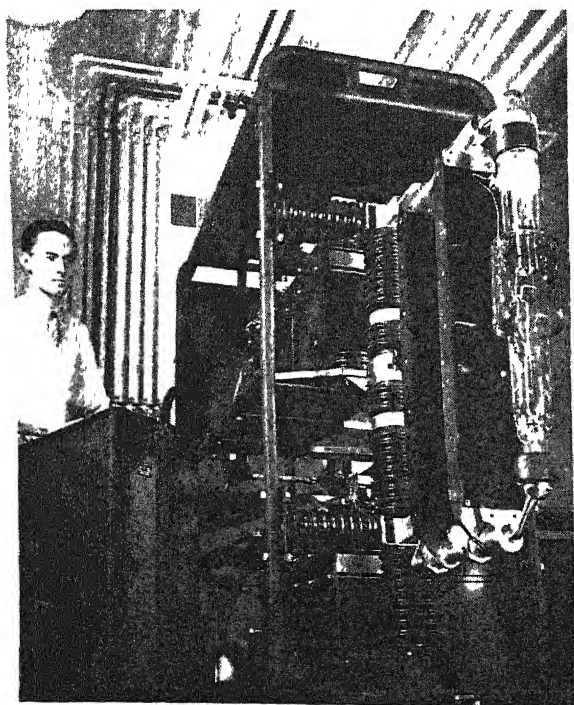
The X-ray machine could look right through the steel on the ejector mechanism and give instantaneous

pictures of what was happening to the brass. All the guess work was taken out of the setting up. Set-up time was reduced to minutes.

Problems like this exist by the hundreds. One of them is the stamping and forging of tough alloy steels and even of metals which are not so tough. Quite often a punch press will be working smoothly and then without warning the stock will begin to seize and gall in the dies. A deep drawing press may take minutes to set up and it may take days. Forging dies may seem to be perfectly designed and made, and yet the hot metal may refuse to flow in them. A thread rolling machine may not produce anything but spoiled threads until an operator who has "genius" in his finger tips makes adjustments which he cannot explain. Quite a few such situations are solved by sheer mechanical intuition, a process which is as costly as it is unpredictable. But now the high-speed X-ray will look through the steel dies almost as readily as if they were clear glass, and will show just what the troubles are.

Use of this machine is not going to be confined to the few big shops. Almost any medium-sized factory can afford one. The exact sales prices have not been announced at this writing, but a 150 KV machine should cost about \$5000 and a 220 KV machine about \$8000. These estimates are based upon \$2400 for the purely mechanical parts, to which will be added a cost for the X-ray unit, varying with the power of the unit. No matter what power a shop may find that it needs, the cost of the machine will be no higher than that of a good turret lathe.

TOOLS AT WORK — This leaves wide open the question of who will be the first to turn high-speed X-ray photography to profit in many



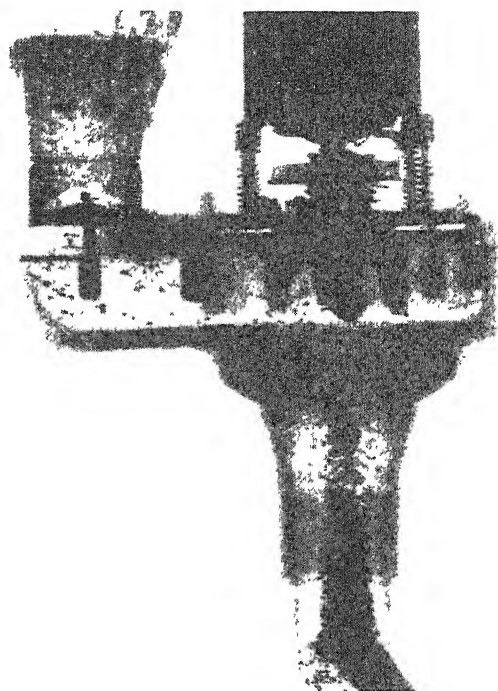
X-ray equipment built by Westinghouse for making exposures at a speed of one millionth of a second. The tube is mounted on the front end of the power source, called a surge generator. Industrial applications of this type of X-ray apparatus are beginning to be explored.

a situation. Some smart shop is going to X-ray the operation of metal-cutting tools on a high-speed lathe working on one of the hard-to-machine high alloy steels, and obtain a worth-while cost advantage over its competitors.

Strange to say, nobody really knows how metal-cutting tools operate. All present knowledge is based upon experience, logic, and assumptions. The high-speed spark or flash camera has yielded some interesting evidence, but it can only photograph dry tools and metals, it cannot look through floods of cutting oil and see how metal is cut under actual operating conditions. But the high-speed X-ray can see just how the chip is bearing on the tool, how the work is depositing packed material or "built up nose" on the cutting tool, and how this nose is being sloughed off by the abrasive action of the chip. After a little experiment to develop methods for using the X-ray, the exact machineability of any lot of steel may be determined by actual observation of chip performance on the first few turns of a lathe spindle. Then the tools can be ground to suit the steel, the speeds and feeds can be adjusted, and the cutting oil mixture and temperature varied. The result will be an ideal set-up made within minutes and with no wastage of expensive raw material, as contrasted to the hours of set-up time and large wastage of present cut-and-try methods. Moreover, every lot of steel will be fabricated at the highest possible speed instead of the present compromise speeds.

Arc welding of metals low in weldability can be improved. Photography has been nearly helpless to study the performance of welding operations, the extremely bright light from the welding arc over-

Study of what happens when dirt passes through the mechanism of a vacuum cleaner is made possible by the Westinghouse ultra-high speed X-ray. The flow of air and relative air velocities can be judged by the distribution of the dirt particles "stopped" in their motion by the penetrating rays.

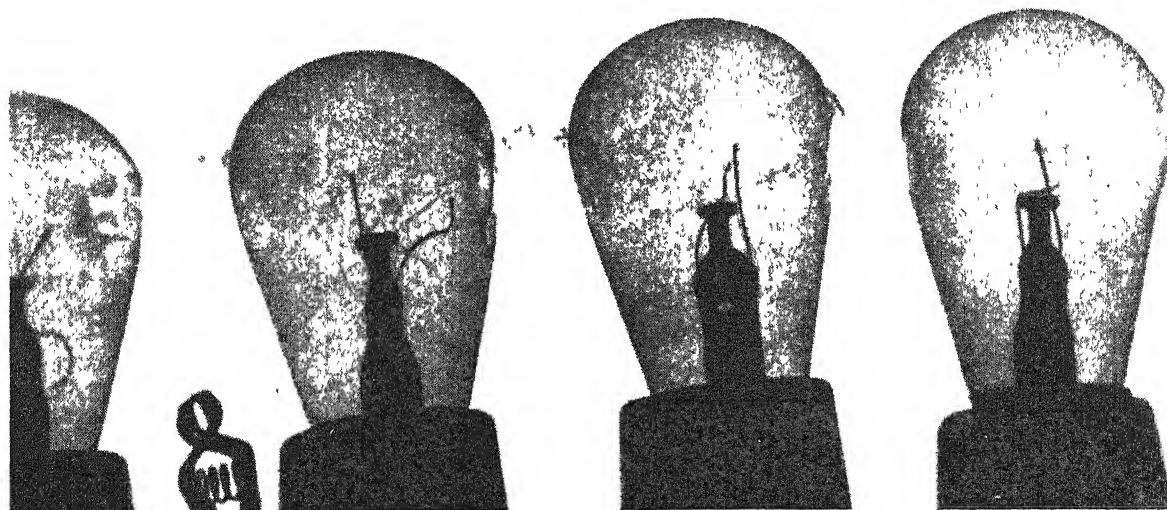


exposes the film. But the X-ray equipment will not be affected in any way by this light. It can follow the processes of experimental welds, show what happens not only at the surface but also beneath the surface of the steel, and so guide the development of better techniques.

Dust-collection systems and all sorts of pneumatic and hydraulic operations can be improved. When handling dusts and other air-borne materials through pipes and ducts there are vexatious problems in keeping the air speeds down to practical limits while at the same time providing sufficient impelling force to carry heavy particles. There are other problems of eddy currents at bends and at joints. Mathematical calculations aided by cut-and-try methods and by experimental observation in glass ducts and pipes

have reduced these problems. The X-ray can take high-speed pictures all along the pipe or duct and register actual behavior of particles in transit. It can show the way to greatest effectiveness and economy.

MAINTENANCE AID—Not all the industrial uses of this X-ray equipment will be in the machine shop. The power plant and the maintenance department will also find applications for it. For example, the high-speed X-ray can help to determine just when finely adjusted equipment such as turbines and gear reducers should be taken apart for servicing. A slower-speed X-ray is able to look through the casing of a machine that is standing still, by carefully positioning the machine parts and then holding them still to be photographed. the presence of



High-speed X-ray photograph of a bullet after passing through four incandescent lamp bulbs. The bullet is seen at the right. Ex-

posure time was so rapid that the glass of the lamps, although they have all been pierced, has not yet had time to collapse.

serious damage can be determined. But with the high-speed X-ray the tell-tale twisting of a slightly damaged turbine blade tip, the slight jumping of a gear when a tooth has worn away from its true curvature, the slight weaving action that worn thrust bearings can impart to a shaft, all can be seen plainly while the observed machine is operating at full speed.

Factory floor space arrangements will be affected. Right now many a complex high-speed high-capacity speed changer or other mechanism is being kept in a position convenient for servicing rather than in the out-of-the-way place where it could do its best work. It has to be watched carefully and to have its lubricants and adjustments checked at such frequent intervals that convenience is necessary. But when the check-ups are made by high-speed X-rays and servicing operations are performed only as and when the X-ray shows them to be necessary, the mechanism can be put where it ought to be.

Instruments will also benefit. Many of them are in full automatic control of extremely complex chemical processes. They have to be taken down at regular intervals just to be sure that nothing is clogging them and that their parts are not worn or out of line. This means stopping the process equipment, but it has to be done; failure of a single instrument could spoil tons of valuable materials. Now the high-speed X-ray can look through the working parts of an instrument while the instrument is functioning. It can give a far more informative picture of how that instrument is working and how long it is likely to keep functioning safely than can any disassembly for inspection.

DESIGN SPEEDED—Machine design is another use for the high-speed X-ray. At present the development of a new mechanism is a long and tedious process of trial and error, with everything run at break-down loads and speeds so as to find out what part will wear or break first. The trouble is, break-down tests are not true tests; they are simply the best methods available for trying to find out in a short time what is likely to happen to a mechanism over a period of years. With the high-speed X-ray taking pictures of hidden parts in motion, the mechanism can be run at normal peak overloads; then true interpretations made of how the parts are behaving. The result will be to find out in hours of research what now takes months of break-down testing of new models.

The exact behaviors of valves in internal combustion engines, of injection mechanisms in Diesels, of shafts making 100,000 revolutions per minute or more, of motion-sensitive and temperature-sensitive governors, are just a few of the things about which guesses are now made but about which the high-speed X-ray will tell the exact truth. With facts like these made available, many of the developments which would normally have taken until 1950 to complete will be ready before 1946 is over.

Observing the bursting of armor-piercing shells was a war use of the high-speed X-ray. This was possible because the X-ray could be located safely behind a steel shield yet look through at what the shell was doing. When testing machines and materials, industrial researchers load plenty of them to the explosion point. Formerly the researchers had to look at the shattered pieces and guess about the sequences in which they broke and about the reasons why one fractured and another did not. Now they can get action pictures and eliminate much of the guess work.

This high-speed X-ray technique is new. Nobody yet knows how all of the techniques for using it will be worked out, what final forms they will take, what profits they will bring. But one thing is sure: The high-speed X-ray will make drastic changes in industry and make them soon.



PUMP CONTEST

*Being Waged Between
Precision and Rugged Units*

A RAPIDLY developing contest is now going on between high accuracy pumps which need careful protection by strainers and rough and rugged pumps which depend very little upon strainers. In fact, the contest is between better and better strainers so the high accuracy pumps can work almost anywhere, and pumps which will handle nearly anything which will pass through a pipe.

Late entries in the strainer field are strainers made of perforated sheet metal so they will not be damaged in cleaning, equipped with quick opening slotted lugs for ease of cleaning and maintenance, and made magnetic if desired to hold even the tiniest of ferrous metal particles.

Countering from the rough and rugged pump side is a pump which

can be mounted at any angle, works with equal efficiency when its impeller is running in either direction, has bearings which are self-lubricating with either oil or water, and has an impeller made of tough laminations, with a quickly removable face plate if any obstructions do succeed in blocking the impeller.

WORKABLE STAINLESS

*Reduces Production Costs
In Some Processes*

LOST-WAX process casters find many of the stainless steels easier to handle than the plain carbon ones. This means that stainless, usually regarded as a "difficult" steel to work in the shop, will find its way into many a complex part on production-cost savings alone.

Fabricators of stainless are having similar results in some cases. One thin part which is fabricated by metals shaving, stamping, and punching processes, is more than 20 percent less costly in production processes when made of stainless as compared to plain carbon steels. The reasons are that the stainless does not suffer from oxidation problems in the shop and does not have to be heat treated to obtain the desired qualities.

MACHINE CONTROL

*Manual or Automatic Question
Has Many Answers*

THE AGES-OLD problem of automatic controls for machines is the question of what to do when a correction of the operation being performed by the machine requires temporary manual control.

There have been three answers to this question: 1; Spend so much money on setting up the machine that manual control never is necessary. 2; Let the machine spoil a limited amount of work rather than resort to manual control. 3; Work out an automatic control that can be made manual if necessary.

The first solution has been used more in process industries than in metals and other fabrication industries. The second has found limited use in the process and the fabrication industries alike. The third is the ideal for metal working, wood working, and other fabrication industries plants.

Latest to join this third group is a control which will automatically control a machine-tool head through as many as 40 different and unrelated functions but can be changed from automatic to manual control and back without disturbing any sequence.

Fuels Rated By Performance

Aimed at New Motoring Pleasure and Economy, Borderline Knock Tests in Petroleum Research Use Road-Performance as the True Criterion of Fuel Quality. Present Cars also Benefit, But Gasolines of Aviation Quality, Tailored to Automotive Needs, Call for Better Engine Design

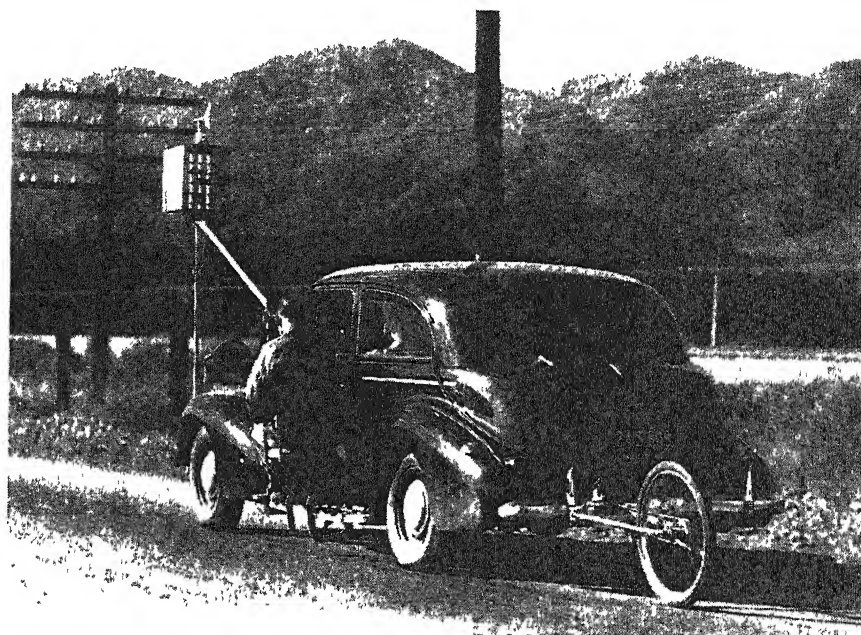
By E. F. LINDSLEY

WHETHER past improvements in automobile engines were responsible for corresponding improvements in gasolines, or whether improved fuels brought better automobile engines, is a question in common with the old saw about the relative seniority of the chicken and the egg. Examination of the progressive stages in the development of the automobile engine indicates that there have been times when gasolines contained more potential road-performance than the engines were able to take out of them, and there were other times, particularly during the recent war, when automobile engines could have utilized better gasoline had it been available.

Today, motorists know that improved gasolines have come from war-time refining and blending experience. In each gasoline, quality is as good as, or better than, its pre-war best. Premium grade gasolines are anywhere from one to five octane numbers higher than their 1941 ratings. The volatility lacking from war-time grades has been fully restored.

But pre-war cars and current production designs, with their moderate compression ratios, ranging from about 5.3 to 1 for early models to approximately 6.7 to 1 for later cars, are not capable of maximum utilization of these new fuels. By the same token, a great deal still remains to be done in tailoring the improved fuels to motor-car requirements; most of the war-time fuel development was directed towards the highly specialized demands of the modern aviation engine.

The engines in a B-29 and the engine in a sport-roadster, for example, differ widely in fuel requirements. Aviation engines fall in the highly stressed engine class. Designed for prolonged cruising operation at about 75 percent of normal rated power, aircraft engines must



Illustrations courtesy Ethyl Gasoline Corporation

Gasoline must satisfy all road conditions. Research crew, shown here testing high-speed performance, will also check fuel's ability on hills in background.

function with optimum efficiency over an altitude range of about 30,000 feet. Idling is secondary; so is starting; but the ability to provide extreme powers for limited take-off periods is mandatory. In consequence, tailor-made aviation fuels with very special characteristics are vital to safe operation.

Automobiles, too, require tailor-made fuels, but here fuels must be tailored to very different characteristics. This stems from the automobile engine's remarkable flexibility that allows high-gear speeds from 5 to 100 miles per hour, plus smooth idling, easy acceleration in traffic, quick starting and warm-up, and amazing durability with little care or maintenance.

In spite of these technical considerations and compromises, there are few cars on the road today that cannot benefit, to a limited extent at least, from the new fuels. Some benefits will be immediately appar-

ent in quicker starting, greater mileage, faster warm-up and much better acceleration and hill performance without the familiar detonation "ping" that spells lost power and engine overloads. Other benefits, less immediate but equally important, are: longer between-overhaul life, reduced gum and carbon accumulations, economies in engine maintenance costs, and generally improved mechanical conditions within the engine. From here on, however, major improvements in performance await new engine designs and further fuels research before truly matched performance between engines and gasolines can be obtained.

DRIVING CONDITIONS — Certain controllable factors, the beloved "variables" of the engineer, cannot be overlooked in the petroleum industry's efforts to blend "super-fuels." The correct fuel for one

engine may fall short of its potential performance in another make of car. Such major engine design differences as valve-in-head or L-head cylinder porting are readily apparent when fuels are tested in automobiles of various manufacture. In fact, extensive tests have shown that engine characteristics, with respect to performance on a given fuel, will vary from model to model and even between cars of the same model. Coupled with these problems in engine design are problems in driver's requirements.

The commuter, who's wife must drive him to the station each morning, insists on snap starting and rapid warm-up. A traveling man, however, is more concerned with high-speed economy and long engine life. People who live in a mountainous region cannot help but judge a gasoline on its ability to provide power on steep grades and at high altitudes. And who can challenge the rancher, who must store bulk gasoline, if he attaches considerable importance to a fuel's ability to resist deterioration in storage. Clearly, a gasoline must be many things to many motorists.

But demands for gasolines with a wide range of special characteristics are not new to the petroleum industry. Civilian motorists are not likely to operate under any more varied conditions than did the armed forces. War experience with all vehicle types from Jeeps to Sherman tanks, in arctic cold and blasting desert heat, showed the refiners how to compromise unusual demands and blend fuels generally satisfactory for the most critical conditions.

Matching fuels to driving conditions consists largely of blending various refinery stocks to vary the

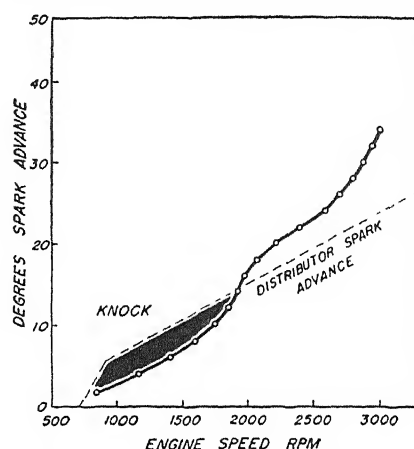
chemical composition of a base gasoline until the desired operating factors are obtained.

Before the war, such blending stocks were generally limited to straight run, thermally cracked, and polymer gasolines. Now, the industry has available the additional components of heavy alkylate, catalytically cracked, hydroformed, superfractionated, and isomerized gasolines. This means that automotive gasolines, more than ever before, can be purposely blended to bring out the best in a car under all driving conditions and in all speed ranges.

FUEL RATINGS — Once the more general requirements of a quality fuel are established, the question arises of comparative rating methods, for testing as well as sales purposes. "Octane rating"—once a term seldom heard in non-technical circles—has come to be widely used, and badly mis-used, as a yardstick of gasoline quality. Octane rating is usually considered as a numerical representation of a fuel's ability to resist detonation, commonly called "knock" or "pinging." The original octane scale was developed by Dr. Graham Edgar, Vice President of Ethyl Corporation, in 1930, and ran from 0 to 100. The higher a given fuel's octane number, the better was its anti-knock quality, or, more correctly, its resistance to detonation under certain standardized conditions of engine speed and load, spark advance, compression ratio, air-inlet temperatures, fuel/air ratio, and engine cooling.

When aircraft fuels of over 100 octane, unsuited to rating on a scale that ends at 100, were developed, and when, in the automotive field,

it became apparent that laboratory octane ratings were often deceptive with respect to actual road performance, more practical methods for testing gasolines became necessary. Road-testing seemed to be the answer, and several road-testing methods evolved, among them the CFR Uniontown method and the more advanced borderline knock method. The Uniontown method, satisfactory for certain types of

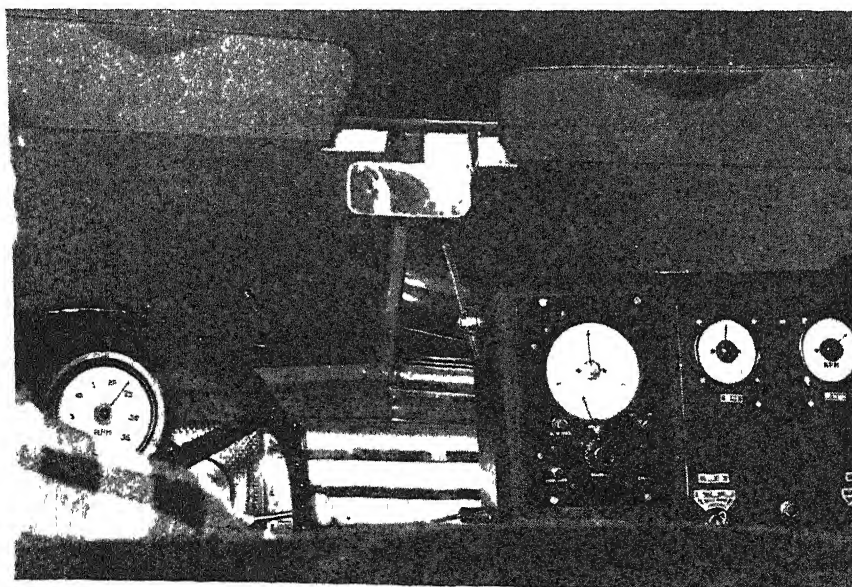


A borderline knock curve; black area shows that fuel knocks at low speeds.

testing, was similar to the laboratory method of bracketing a test fuel on the basis of maximum knock intensity as compared with fuels of known octane number. Since knock intensity, without regard to the engine speed at which the knock occurred, formed the basis for octane ratings with the Uniontown method, it did not offer a practical tool for studying the effects of chemical composition on road performance in different operating ranges. Consequently, two fuels with the same octane rating might knock at entirely different driving speeds.

BORDERLINE TESTS — The borderline knock method enjoys an advantage in that the test results provide a curve covering the entire driving speed range in contrast to the single numerical rating from the laboratory and Uniontown methods. With the borderline method, a series of test runs, at successively greater speeds and spark advances, spot points on a graph. These points shape into a curve with contours truly indicative of road performance when the graph is examined by a person acquainted with the testing method. In the terms of the petroleum engineers, the borderline knock test curve is the dividing line between knocking and non-knocking operation and it shows graphically a fuel's ability to tolerate spark advance throughout the entire speed range. For testing by this

Engine speed, spark advance, temperatures, and many other critical items are constantly checked by the petroleum engineers who ride in fuel research cars.



method, a test car is equipped with a non-automatic distributor that can be varied manually by the driver, a suitable spark advance indicator, and an engine tachometer.

Briefly, the procedure for determining the borderline curve for a fuel is this. The spark is set manually to a relatively low advance, usually 2 to 6 degrees before top dead center. The car is slowed down to as low a speed as possible in high gear, generally about six to eight miles per hour, and then accelerated with wide open throttle. As the engine picks up speed after beginning to knock, the knock intensity lessens, and the speed at which the knock dies out is noted. This gives one point on the borderline curve, representing the two dimensions on the chart: spark advance (vertical axis) and knock-die-out speed (horizontal axis). The spark is then advanced two degrees and the entire procedure repeated to obtain the second point on the curve. This procedure is continued until the complete curve has been established for the entire spark advance and speed range under consideration. It should be remembered that the borderline curve obtained by this procedure is indicative of the anti-knock qualities of the test fuel only in the particular engine in which the tests were conducted. Because of differences in engine characteristics, it is necessary to test a given fuel in representative engines of various types.

BLENDING—Borderline tests are of more than academic interest to both the petroleum engineer and the user of the fuel. They furnish practical working data that enable selection and blending of a fuel that will fill the driver's needs, be they general or specialized. For example, the laboratory octane rating for a saturated type fuel, chemically similar to pre-war straight-run gasolines, may show that fuel to have good susceptibility to lead—that is, the addition of quantities of tetraethyl lead up to three cubic centimeters per gallon materially improves the anti-knock qualities and raises the laboratory octane rating. A borderline road test, however, might show that the improvement due to the addition of lead was confined almost entirely to the high engine speed range. Since saturated straight-run fuels are characteristically good at high speeds and weak in anti-knock qualities at low speeds, a certain amount of blending would be necessary to bring up the low speed end of the curve. This might be accomplished by adding an unsaturated fuel with good low speed anti-knock

characteristics and poor high speed anti-knock performance. Thus a gasoline could be blended that would perform better in all speed ranges than would either the saturated or unsaturated gasolines alone.

It is because of the advantages gained by such blending that future gasolines hold so much promise; for, as mentioned previously, there are a great many more fuel types, or blending stocks, available as the result of the war. It is worth noting that a satisfactory blend cannot remain static over a period of years or be considered the one best all-around fuel. Changes in automobile design require parallel changes in fuels. An example of this is the development of new transmissions that automatically prevent engine loading below certain crankshaft speeds. With such a transmission, a fuel blended for high anti-knock qualities at low engine speeds would, in a sense, be wasting its low speed anti-knock qualities. Similar problems will appear if supercharging becomes a common feature of automotive engine design.

Many commercial truck and fleet operators are advancing the spark mechanism on present-day equip-

ment to take advantage of the new fuels. Past practice has been to advance the spark until a light knock was evidenced during high-gear acceleration. This was the point of marginal detonation for the fuels available at that time. Now, however, it is possible to advance the spark so far that efficiency is actually lost, without encountering the point of marginal detonation, or, for that matter, any detonation at all. In essence, the fuel has such anti-knock qualities that the engine's compression ratio is too low to force detonation. Operators planning a spark advance program should now advise shop personnel to adjust the spark to the point of maximum power instead of the point of marginal detonation.

Looking into the future, automobile engines are certainly going to be more efficient, although the exact mechanical means through which this efficiency will be gained is not yet revealed. Whatever the improvements in engine design, however, modern fuels are available to match them and give both motorists and commercial users a new high in motoring pleasure and economy.



CLOTH TREATMENT

*Makes Many Materials
Water- and Mildew-Proof*

A WAX EMULSION that can be added to the rinse water of the family wash provides easy and economical means by which housewives or laundries will be able to make clothing, drapes, and other textiles water resistant, according to scientists of the Socony-Vacuum Oil Company, Inc., who developed the fluid.

During the war the quantity of the fluid available for civilians was limited because the armed forces used large amounts for tent duck, uniforms, blankets, and other fabrics, making such articles both water and mildew repellent.

The emulsion will have a wide range of use: such articles as sports jackets, slacks, shirts, play suits, fabric shoes, cloth hats, dresses, and shorts are cited as examples of articles especially suited for the treatment. Its application is obvious in protecting window shades and drapes that are subject to outside moisture or to dampness existing in bathrooms and kitchens, as well as for giving a water resistant finish to furniture covers.

Tests have shown that the wax-treated fabrics become not only wa-

ter resistant but also do not spot easily. Because water does not adhere to the cloth, a suit, dress, or other garment retains its press longer and is less likely to wrinkle.

Since the emulsion does not fill the spaces between the fibres, clothing that has been treated retains its porous qualities and summer clothing, therefore, remains ventilated and cool. The emulsion does not make a fabric stiff but, if anything, is likely to give it a softer feeling to the touch. The wax itself is indiscernible and does not alter the color or appearance of the fabric to which it is applied.

The new emulsion, milky in appearance, is non-toxic and non-flammable. It is made up of minute paraffin wax particles, suspended in an aluminum salt and water solution. A simple form of a wax emulsion, it is explained, could be made by using soap to emulsify the wax in water. Such an emulsion, however, would deposit both soap film and wax on the cloth, the soap's affinity for water tending to offset the water-shedding characteristics of the wax.

In laundering, the wax emulsion can be used in conjunction with starch, and it can be used also with moth-proofing and mildew-proofing processes if desired.

Air Transport Progress

Passenger Comfort, Cargo Handling, Navigation and Traffic Control, All Involve Problems Basic to Full Realization of Air Transport's Potential Value. Specialists from Other Fields—Biomechanics, Lighting, and Even Air-Conditioning—are Enlisted to Add Comfort and Safety

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

AVIATION today ranks equally with rail, highway, and water carriers, and is assuming its long-predicted place in the transportation scheme of this country both at home and abroad. Currently, the airlines of the United States have approximately twice the pre-war number of seats in operation, in final stages of construction, or in conversion. Programs planned for the next two years will better than double this carrying capacity. Opening up of world trade routes will further add to the importance of air transportation, and the air-freight field, being explored by sev-

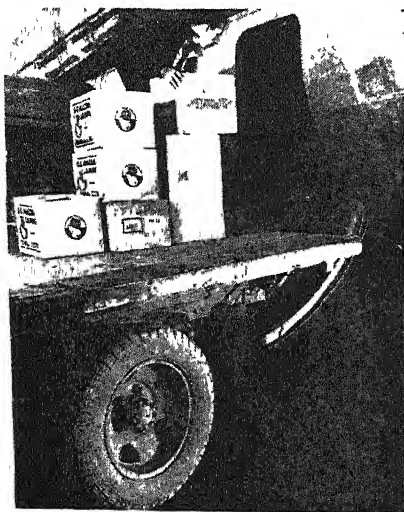
er and Vice President of American Airlines. The papers presented at the meeting stressed the realization that the fullest development of the opportunities open to commercial aviation depends to a large extent on practical and economical solutions to a variety of technical problems.

CONTROL-DECKS—The problem of crew comfort on the control-decks of long-range aircraft was once considered to be satisfactorily solved when the pilot had a comfortable cockpit in which to sit. On the larger over-land and over-water airliners, this now appears as a serious misconception in the light of present requirements for a multiple or relief crew. Possibly, as operation schedules increase in speed and flights shorten in duration, multiple crews will disappear, in which case only a pilot, co-pilot, radio operator, and flight engineer will be carried. But for present-day flight personnel, the design of crew quarters must be something more than an afterthought.

Some of the more important design considerations in this respect

are the relative distance between the pilot and co-pilot, the relation of the pilot and co-pilot to the instrument panels and controls, and the location of the flight engineer's station, which should be close to the co-pilot and visible from the captain's station. Suitable locations must also be found for the radio operator and the navigator. Among the suggestions offered by Captain H. J. Chase, of Pan American Airways, Inc., in a discussion of control-decks, was a thoroughgoing analysis of pilot fatigue as related to vibration. Since vibration is known to be fatiguing to personnel and to reduce their operating efficiency, it appears that special shock-mounting of all crew personnel stations, including their chairs, instruments, accessories, and tables would be worthwhile.

Visibility, another vital factor, is generally good on modern airplanes. However, some designs have relatively small windows with moldings in direct line with the pilot's vision. Such an arrangement, of course, adds to eye strain and fatigue, and limits the visibility with a resultant lowering of safety. A number of recommendations were made along this line. Visibility should be available in all directions, with curtains to eliminate intense glare. All instruments should be easily readable and variable instrument illumination should be provided; again, glare reduction is important. Most aircraft instruments have rim lighting, spot lighting, or other means of



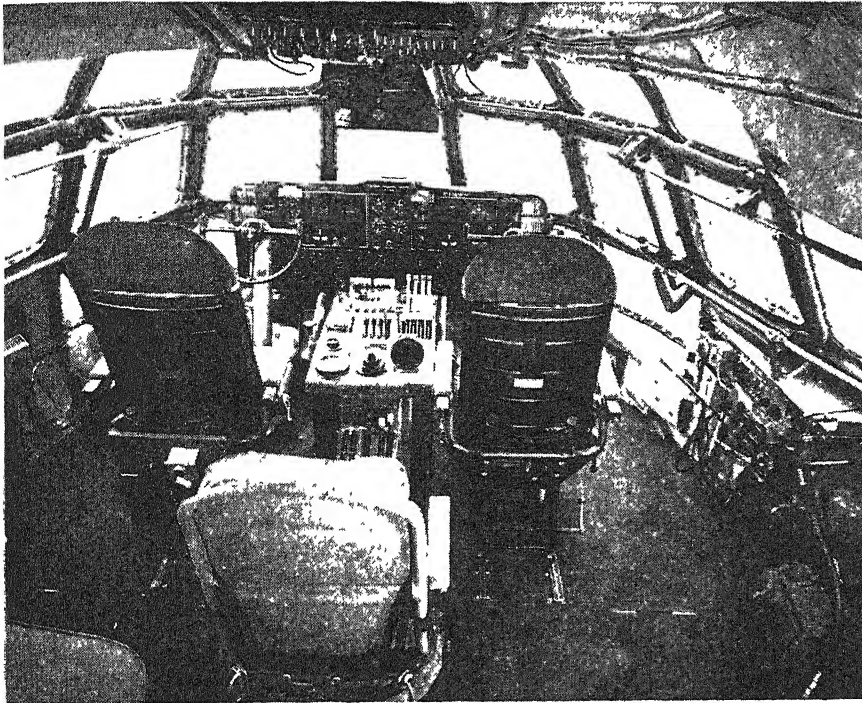
Truck-level cargo doors save handling, are partial answer to loading problem

eral airlines, has been found capable of providing tremendous expansion possibilities.

This, in essence, was the keynote of a recent meeting of the Air Transport group of the Society of Automotive Engineers, as expressed by William Littlewood, S.A.E. of-

Concealed
fluorescent lighting
contributes to
passenger's
sense of comfort
and
well-being





Photographs courtesy Boeing Aircraft Company
Crew comfort and convenient control set-ups keynote modern flight-decks

illumination, but it was noted that none of the methods is comparable with lighting from behind the dial face such as is used in home radios. Also, some dials might be improved by a change from a circular to a vertical scale.

Control-deck noise, always conducive to fatigue, must be held to a level that permits crew members to converse without effort. Not only does noise render the co-operation of the crew members difficult, but it may also give rise to dangerous errors and misunderstandings on long flights.

Many of these studies of crew comfort hinge on biomechanics—the combined study of biology and mechanics—and recent work in this field has materially improved the lot of all who fly. Some of the developments, such as the pressurized cabin, high-altitude flying suits, and improved food for both pilots and passengers, represent a tremendous amount of research work on the part of highly specialized medical men as well as aeronautical engineers and technicians.

CARGO HANDLING—Passing from considerations of crew comfort to air-cargo problems, M. B. Crawford, Chief Equipment Engineer for United Airlines, discussed some of the loading and unloading appliances now coming into the air-cargo picture. The front cargo-door height on the familiar Douglas DC-3 transport is nearly ten feet above the ground while the rear cargo-door requires a lift of about four feet from the ground level. Doors

on other planes range between these two heights and, consequently, the problem of loading is not an easy one. Body lift trucks are one answer. The normal lift truck body has a height of four feet and can be extended up to 14 feet so that any airplane door height can be accommodated. Fork lifts are also extremely useful for any cargo that is too heavy to lift by hand.

Cargo discharge chutes, with gravity as the unloading force, are generally accepted as the most logical and practical means of handling the out-bound cargo. There have been many adaptations of the cargo chute, but the possibilities are not yet exhausted. Straight chutes have not been entirely satisfactory because some of the heavier packages come down too fast, while the lighter packages have a tendency to stick half way down. Moreover, some of the chutes are too heavy and require too much maintenance. Belt loaders have been of limited service because they can move only small packages from the lower to the upper end of the belt, and they require an additional cargo handler.

The entire answer to loading problems cannot be found in ground handling machinery alone, however ingenious. Airplanes themselves must be designed to suit cargo operations. Such features as high-wing design; at least two loading doors not less than six by eight feet in opening, one at each end of the compartment; a substantial floor with skid strips, tie-down fittings, and stressed to one thousand pounds vertical pull; and a clear cargo com-

partment equally distributed around the center of gravity to simplify weight and balance problems, were offered by Major David W. Long, of the Air Transport Command, as recommendations based on past military experience. It was also pointed out that the true aerial freighter, carrying nothing but cargo, might well be relieved of some of the more stringent weight restrictions imposed on passenger aircraft for safety reasons.

CABIN LIGHTING—Redoubled efforts in the direction of passenger comfort were also reported by engineers now free once more to concentrate on the more luxurious aspects of air travel. Attention was focused on fluorescent indirect lighting by Raymond A. Rugge, of Curtiss-Wright Corporation. Fluorescent lighting promises to aid passenger vision, induce relaxation, and produce a mild sense of well-being through the use of concealed light sources that give low values of contrast. Passenger cabin lighting objectives are summed up as: adequate illumination of all objects in the field of view, with a recommended minimum of five foot candles; soft white light that accentuates the color and freshness of objects and fabrics; light sources concealed or in a fixture of low surface brightness; adjacent reflecting surfaces of low surface brightness compared to the reflection of other objects in the general field of view; aisle lights for night use; and special passenger reading lights in combination with the general illumination.

AIR CONDITIONING—That there has been considerable engineering attention given to aircraft cooling was indicated in a report on "Refrigeration for Air-Conditioning Pressurized Transport Aircraft," by Bernard Messinger of Lockheed Aircraft. Popular misconceptions notwithstanding, aircraft air-conditioning does require refrigeration. Although it would at first appear that airplanes can be flown at a sufficiently high altitude to avoid excessive ambient temperatures, this is only approximately true for unpressurized aircraft and not at all the case for pressurized transports.

There are several reasons for this rather surprising fact.

If it is assumed, for example, that an outside or ambient temperature of only 75 degrees, Fahrenheit, prevails on a hot, summer day, at an altitude of 7000 feet, the cabin temperature, without the removal of heat, will run substantially higher. First, there are numerous internal

sources of heat in the cabin, the occupants, solar radiation through transparent surfaces; various electrical devices, such as radio equipment, inverters, motors, and lights, and a slight effect due to thermal lag. But there is another and somewhat more involved reason. This concerns the great difference between the static temperature and total temperature due to stopping of air relative to the airplane. For older type transports which have a climb speed of 110 to 120 miles per hour, this factor amounts to only 2 degrees, Fahrenheit, but for present-day aircraft, it may amount to 5 or 6 degrees, Fahrenheit, during climb. In level flight it can become 15 or 20 degrees, Fahrenheit, while in some high-speed military fighters this temperature rise reaches 50 degrees, Fahrenheit.

It may be noted that this effect is present not only in the air that is stopped while being brought into the airplane, but also in the boundary layer which envelopes the entire external surface. The practical result is equivalent to placing the airplane in an atmosphere at a temperature very nearly equal to the total temperature. All of these temperature elevating factors make it difficult to maintain the cabin temperature within less than 10 to 20 degrees, Fahrenheit, of the ambient static temperature, even though adequate ventilation flow rates are provided. Thus, at 7000 feet altitude on a summer day, the cabin temperature might range between 85 and 95 degrees, Fahrenheit.

While the plane is taxiing, further cabin temperature difficulties arise, and passengers may be acutely uncomfortable if the day is at all warm. Under such circumstances, the only alternative to refrigeration is the use of prohibitively huge cabin fans. Reduced taxiing time may help to solve this trouble, since refrigeration trucks or their equivalent, offer an acceptable degree of air conditioning when the plane is not moving. The refrigeration equipment, however, must be quickly removable.

TRAFFIC—"The air transport industry is today faced with a serious situation. Air navigation and traffic control development has not kept pace with the expanding volume of traffic." These words prefaced a talk on operational problems by Captain S. P. Saint, of American Airlines. Further comments indicated that fully-equipped modern airliners are still held to the same instrument approach weather minimums that were established for single-engine, poorly instrumented

"mail-planes." In this situation, traffic control is the dominant factor and little has been done to eliminate the fundamental limitations that have prevailed since the late 1930's.

Recommendations for remedial measures include a central traffic control agency with means to coordinate traffic control, plus self-checking control devices, and a clarification of the relationship of the pilot to the automatic systems. Many worthwhile advances could stem from material recognition of these recommendations. To summarize a few of them radar and other devices could be incorporated to reduce the minimum practical separation between flights, standardized judgement on minimum separation could be built into and administered by the automatic system, coordination of movement would be automatically and instantaneously accomplished; provision would be made for regular over-control of the system by human dispatchers. The possibilities inherent in radar techniques would be brought into proper focus by application of these principles, which would incorporate every known principle of safety engineering.

WASP MAJOR

Is World's Largest Aircraft Engine

SAID to be the most powerful aircraft engine yet in production, the new Pratt and Whitney Wasp "Major" delivers 3650 horsepower with a dry weight of 3405 pounds. Pointing the way to further progress in air transport through the use of larger, more powerful, and more efficient engines, the 28-cylinder "Major" powers such outstanding planes as the 108-passenger, Doug-

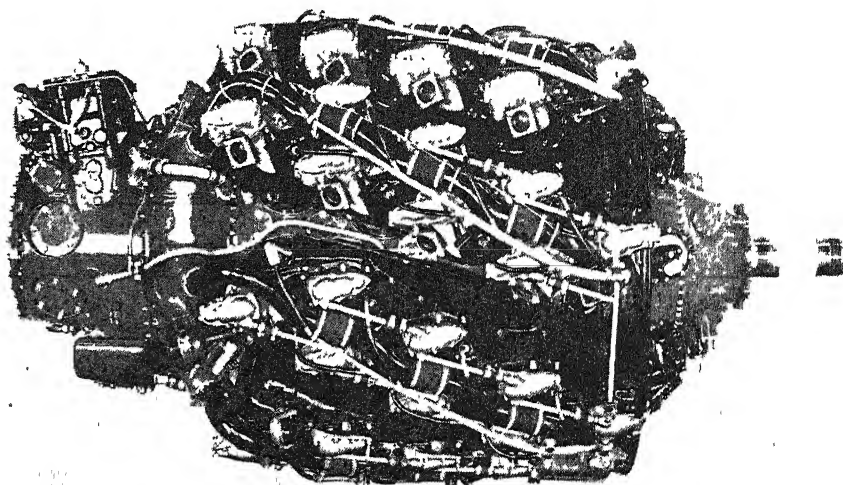
las C-74 Globemaster, the 114-passenger, Boeing Model 377 Stratocruiser, the commercial version of the B-29, and the 105-passenger Martin Mails flying boat.

In addition to the Wasp "Major's" remarkable power/weight ratio—less than one pound per horsepower—the specific power ratio is 84 horsepower for each of its 4360 cubic inches of piston displacement, and fuel consumption is unusually low, an important factor in long-range operation.

A number of design features contribute compactness, accessibility, and efficient cooling to the engine. The cylinder arrangement, emphasizing low frontal area, consists of four banks of seven cylinders each, distributed in a helical pattern that allows each individual cylinder to receive cooling air directly from the air stream rather than from heated cylinders ahead. Supplementing this carefully directed flow of cooling air are deep-finned, forged aluminum cylinder heads and scientifically contoured baffles.

Conventional ignition harness installations have been discarded in favor of interchangeable magnetos, one for each cylinder bank. High altitude performance is boosted by the use of a hydraulically driven, variable-speed supercharger that is automatically controlled. Improved vibration dampers reduce crankshaft vibration and the radial mounting of the accessories about the periphery of the accessory drive case is an innovation that should make for a substantial increase in service maintenance accessibility.

The design and development of the Wasp "Major," authorized late in 1940, was accomplished in approximately five years, a relatively short time for the introduction of an engine incorporating so many advanced features.



Courtesy United Aircraft Corporation

Side view of the Wasp "Major," showing the four banks of cylinders

Ion Exchange

Purification of Liquids and Gases, Selective Recovery of Valuable Materials, and the Removal of Undesirable Substances from Chemical Compounds, are Problems that Often may be Solved with Ion Exchange Resins. Both Industry and the Laboratory Find These Resins Valuable

By HOWARD C. E. JOHNSON, Ph D.

Chemical Editor, *Chemical Industries*

INDUSTRY is constantly finding new ways to save time and money by the use of synthetic ion exchange resins. These resins have proved their worth not only in the chemical industry—as in the purification of formaldehyde—but also in such diverse operations as purifying pectin from grapefruit rind, removing harmful fluorides from drinking water, and recovering quinine from cinchona bark.

Ion exchange makes use of synthetic resins obtained from compounds containing free acidic groups such as carboxylic acids, or basic groups, such as amines. When a solution of electrolytes is passed through the acidic resins, the metallic ions combine with the resins to form what might be considered an

insoluble, resinous salt. In the same way, the acidic portion of an electrolyte—sulfate, fluoride, or the like—is absorbed by basic resins.

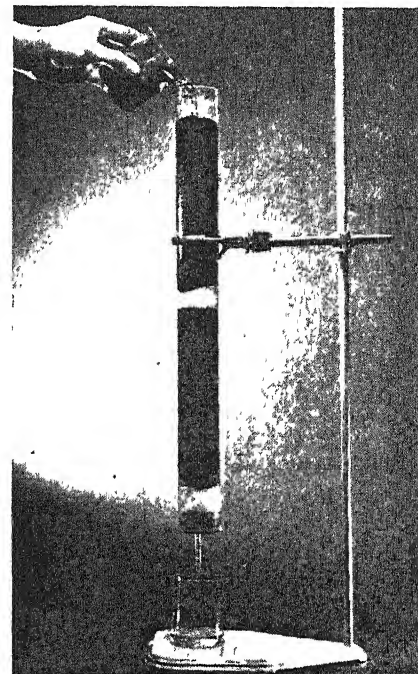
Actual "exchange" is involved because absorption of one ion requires liberation of another; otherwise the reaction would not be balanced. In simple water softening, for example, sodium ions might be liberated while the calcium and magnesium ions, which cause hardness, are removed. In another type of reaction—anion exchange—chloride might be substituted for sulfate or fluoride. Also, resins have been developed which liberate hydrogen and hydroxyl ions. These combine to form water and the solution is completely demineralized.

The principle of ion exchange,

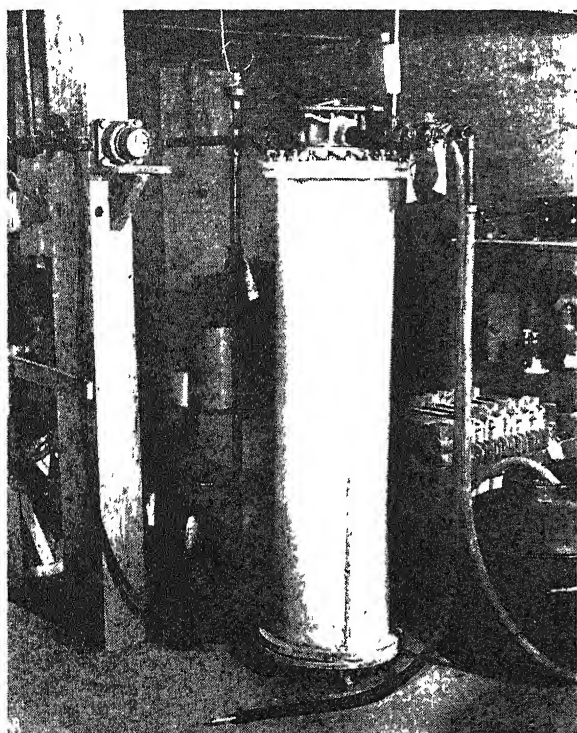
known for exactly one hundred years, has been applied industrially during the last 40 years—primarily for water softening—and only within the past 10 years have synthetic organic resins been developed which extend its usefulness.

These materials are serviceable not only for removal of impurities but also for recovery of valuable substances; for separation; for addition of certain electrolytes to solutions, and for a variety of miscellaneous operations.

CHEMICAL INDUSTRY USES—An important industrial application of anion exchange is the removal of



Courtesy Resinous Product & Chemical Company
Ion exchange in laboratory quantities.
Top resin layer absorbs metallic ions,
bottom layer absorbs acidic radicals,
liquid in bottom beaker is pure water



Scopolamine—
a medicinal alkaloid
used as a sedative
and sometimes
called "truth serum"—
is recovered by
a single-resin ion
exchange in single
tanks such as
this one at Debrulle
Chemical Corp.

formic acid from formaldehyde. This is a specific example of the general process for the removal of acidic impurities from liquids or gases. Particularly in the laboratory have ion exchange materials been used to remove undesirable impurities from exhaust gases.

Sometimes the acid itself is a

valuable product, and ion absorption provides a means of reclaiming it, as in the recovery of tartaric acid from wine lees. Similar recoveries of precious metals, such as gold and platinum, are accomplished by converting them to complex acids which can be absorbed by the proper resin. Cation exchange has also been used in a comparable fashion to recover copper from the waste liquors in the cuprammonium rayon process.

Compounds manifesting different degrees of acidity or basicity can be separated by selective absorption on ion exchange resins, and this principle has been applied to the separation of the amino acid mixtures as described in *Scientific American*, February 1946.

QUININE RECOVERY—The recent war in the Pacific increased our need for anti-malarial drugs, and at the same time it cut off our supplies from the Netherlands East Indies. Consequently, a great deal of work was directed to the possible use of ion exchange to recover quinine and related alkaloids from the lower quality South American cinchona barks.

The absorption of alkaloids by cation exchange materials had been known for many years, but commercial utilization of the knowledge was retarded by lack of suitable means for recovering the absorbed material. This latter problem was solved in 1941, and the process has since been adapted by the Cinchona Research Unit of the United States Army to provide a portable unit for quinine recovery at the site of harvest. The portable plant, which weighs only 1500 pounds, can process 13,000 pounds of bark a month, yielding 170 pounds of totaquine.

Of simple construction, the plant produces the quinine concentrate in the field from wet bark. Heretofore, dry bark had to be gathered from the jungle—generally an almost impossible task insofar as the South American areas were concerned—and shipped to a permanently located extraction plant.

WATER TREATMENT—Demineralization of sea-water and the production of a substitute for industrial distilled water by ion exchange are processes that have been described in detail in *Scientific American*, June 1944 and September 1944. A closely related problem is the removal from water supplies of excess fluorine, which is now recognized as the cause of mottled teeth prevalent in some localities.

Fluorides, it has recently been determined, can be rapidly and efficiently extracted by passing the

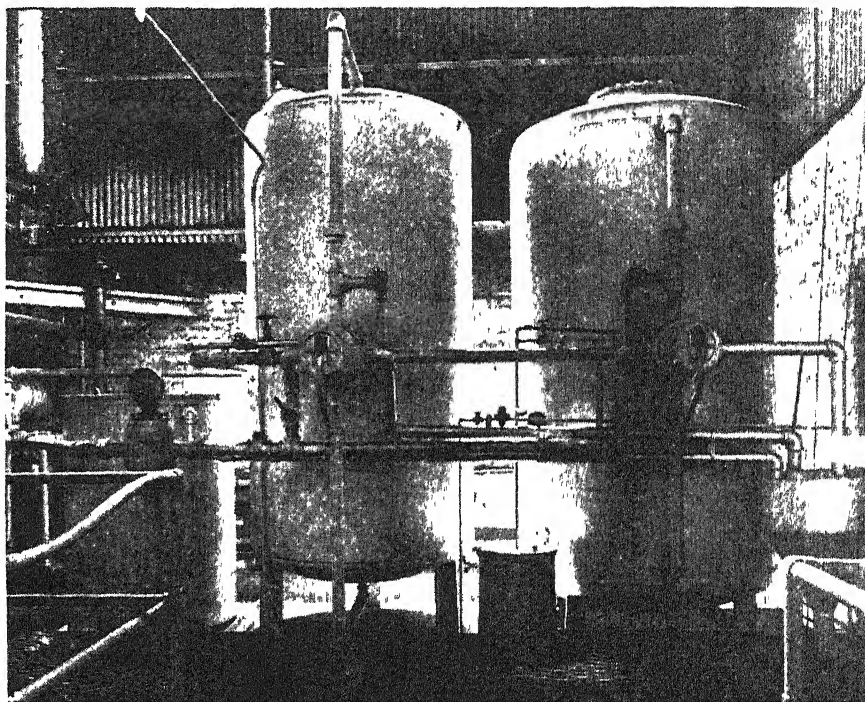
water over a bed of an ion exchange resin which has been specially treated with a solution of an aluminum salt, generally aluminum sulfate. The exchanger is not depleted in the process and can be used repeatedly by intermittently regenerating the resin with an alkaline solution which removes the accumulated fluoride ions.

Although it has been known for some time that fluorine may be removed by bone, chemical removal methods are relatively recent developments. The problem involved finding a substance which would not leave any element in the water that was not already present, and which

stuffs. Among these is the preparation of a high quality pectin from grapefruit hulls by the use of an acid-regenerated cation exchanger. Here, the resin is added to a slurry of the rind in water and is later removed by centrifuging. This treatment removes metallic impurities from the material.

In another commercial process, part of the calcium is removed from milk to make it more digestible for infants. This is one of several milk products modified by ion exchange.

As mentioned above, acidic impurities are often removed from products with ion absorbents. This has been applied in the food indus-



Courtesy Rohm and Haas Company

Typical ion-exchange installation for purifying boiler feed water

would not impair the potability by increasing undesirably the concentration of any ordinary constituent.

There were three possible approaches: precipitation of the fluorides, unsatisfactory because of their high solubility; desalting, which has proved uneconomical so far; and selective absorption by a solid. The latter has proved most promising.

Although a number of materials—titanium oxide, zinc oxide, copper hydroxide, copper sulfide, and others—answered most of the necessary qualifications, their principal disadvantages proved to be ready disintegration, low capacity, and inability to be regenerated. The use of resinous exchange materials has become a satisfactory answer for commercial use.

FOOD INDUSTRY—A number of ion exchange applications have been found in the manufacture of food-

try, again, to remove the chloride ion from glutamic acid hydrochloride, and to remove undesirable acids from dextrose, pectin, and vitamin B extracts.

Higher yield and improved operation have also been obtained in beet sugar production by the removal of organic and inorganic non-sugars by ion exchange absorption.

ION EXCHANGE COSTS—While the initial cost of some exchangers is relatively high, they are long-lived in most applications so that investment can be amortized in the same manner as other equipment. There are in use a number of plant installations where the exchangers have been operated for thousands of cycles.

Operating costs depend upon the type of exchanger required, the quantity and nature of electrolytes to be removed, the proportion of re-

moval required, and the nature of the regenerant. In a typical example of water treatment, assuming that soda ash and sulfuric acid cost two cents per pound, demineralization would cost 29 cents per 1000 gallons

OTHER FACTORS—The chief limitation of ion exchange is the capacity of the resins. The process is limited to solutions of relatively low concentration, as the concentration of electrolytes increases, the volume of solution which can be treated before exhaustion of the resin decreases to a point where it is less than the volume of the exchanger.

Also, valuable materials are obtained only as relatively concentrated solutions which require evaporation or other means of concentration in order to obtain the desired material.

The ramifications of this principle are such that it reaches into almost every industry. Demineralized water is desirable for boiler feed and cooling water in all industries. Electroplating processes benefit from solids-free water, especially freedom from calcium, magnesium, sulfates, and chlorides. For producing high purity chemicals in general, pure water is an indispensable raw material. It is likewise important in distilleries and breweries, in pharmaceutical manufacture, in dyeing, and in other textile processing techniques.

Ion exchange is expanding steadily in scope and utility and it will undoubtedly become of increasing value in a multitude of industrial operations

• • •

STREPTOMYCIN

*Will be Increasingly Available
As New Plants are Finished*

INCREASING evidence of the growing importance of biochemical processes in the chemical industry is presented by plans now underway to construct streptomycin production facilities.

Streptomycin was not discovered by accident as was penicillin. Dr. Selman A. Waksman, of Rutgers University, experimented for years with soil microbiology before finding that *Streptomyces griseus* was effective when used against the microorganisms causing such diseases as typhoid, cholera, tuberculosis, influenzal meningitis, and others.

When Dr. Waksman brought his discovery to commercial producers

of biologicals, a team of 50 scientists were immediately assigned to work toward the goal of transforming streptomycin from an experimental substance to a therapeutic agent ready for application.

Now, with many questions answered due to experiments conducted on both animals and humans, streptomycin has moved from the laboratory and the pilot plant into large scale production. Merck and Company, Inc., is constructing new units to supplement its present plant facilities and Eli Lilly and Company is also building a plant for the production of the new drug.

SYNTHETIC LUBRICANTS

*Are Made from Gases,
Contain No Petroleum*

Now being synthesized on a commercial scale from natural or other hydrocarbon gases, two series of synthetic lubricants were recently announced by units of Union Carbide and Carbon Corporation. One series, which is essentially insoluble in water, is designated by the symbol "LB" followed by a number representing the viscosity at 100 degrees Fahrenheit, in Saybolt Universal Seconds, while the other series, the members of which are soluble in water at room temperature, is known as "50-HB."

These new lubricants, called "Ucon," are made from gases, contain no petroleum oils, and are inherently more expensive to produce than the best petroleum lubricants now sold.

Because of its special properties, the LB series is best adapted for the lubrication of machinery, including internal combustion engines. LB-300 has already been marketed in certain areas as Prestone Motor Oil for use in automobiles, buses, trucks, and tractors. This lubricant has been found successful for Diesel engine use and the Army Air Forces and the Air Transport Command have used lubricant LB-550 in aircraft engines. (See first report, page 84, February 1946 *Scientific American*.)

In addition to use in internal combustion engines, there are many places where the special properties of the LB series of lubricants—such as low pour point, high viscosity index, and non-sludging characteristics—have been utilized to advantage. Such uses include their applications as hydraulic fluids and plasticizers. Further utilization as lubricants is being studied in such fields as powdered metal bearings, transmission and differential lubricants; electrical motors; textile machinery; wire drawing; metal roll-

ing and stamping, and many others. Greases exhibiting unusual high and low temperature properties have been prepared from oils of the LB series, but, so far, on an experimental basis only.

The 50-HB series of synthetic lubricants is characterized by high viscosity index, low pour point, and in other properties is similar to the LB series. Compounds of the 50-HB series, however, are completely soluble in water at room temperature, with the water solubility decreasing as the temperature is raised. The series will depress the freezing point of water to a limited extent. Members of the 50-HB series having viscosities of more than about 100 Saybolt Seconds at 100 degrees Fahrenheit, have very little swelling action on natural rubber and are excellent lubricants for both rubber and metal. Certain of these products are being used in hydraulic fluids including brake fluids, as high-temperature heat transfer media and textile lubricants, in cutting oils, for wire and metal drawing operations, and other uses.

While these materials are not in general competitive with natural petroleum lubricants, they presage a tendency—apparent in both the chemical and petroleum industries—to rely less and less on natural products and more on synthetic "tailor-made" materials designed for a specific purpose.

HYDROGEN PEROXIDE

*Now Industrially Available
In Concentrated Form*

A CONVENIENT source of oxygen for industrial purposes is now available in the form of 90 percent peroxide. Heretofore, hydrogen peroxide of high concentration has been only a laboratory curiosity. Industrial material of 30 percent strength and the ordinary antiseptic, containing only 3 percent, have long been used, but the highly concentrated substance was thought to be too hazardous for practical use. Now, intensive research has shown that hydrogen peroxide of high purity is actually a stable material.

The possible industrial applications of this chemical are innumerable. Hydrogen peroxide is an ideal oxidant in that it leaves no residue. In its concentrated form it promises to be of great utility in many new chemical reactions since, being relatively free from water, it will react faster and more completely with organic compounds. Moreover, each volume of the 90-percent peroxide yields over 400 volumes of oxygen—three to four times as much as the 30 percent material.

Keeping the Heat In

Chemically Inert, Light, Strong, and a Highly Efficient Insulator, Magnesia, Mixed with Asbestos Fibers, Provides an Easily Installed Insulating Material for Boilers, Pipes, and Similar Surfaces. Above 600 Degrees, a Lining of Diatomaceous Earth Protects the Magnesia

INCREASED utilization of heat energy, and its wide-spread applications, make thermal insulation a problem of prime importance in modern industry. The vast majority of processing and fabricating operations require heat transfer, under controlled conditions, at one or many points in the productive process. Although steam power is, perhaps, the most quickly called to mind, numerous industries, including chemicals, plastics, petroleum refining, paper manufacture, and a host of others, are vitally dependent upon insulation as their various heated materials pass through transfer pipes, distilling units, heated rollers, or other equipment requiring heat and pressure to function.

Early in the development of steam engineering, it was recognized that radiation, convection, and conduction from boilers and hot lines were robbing steam engines of much of their efficiency. Insulating materials of various types were experimented with, most of them of an organic base—vegetable or animal matter—and most of them were subject to decomposition at around 300 degrees, Fahrenheit. Later,

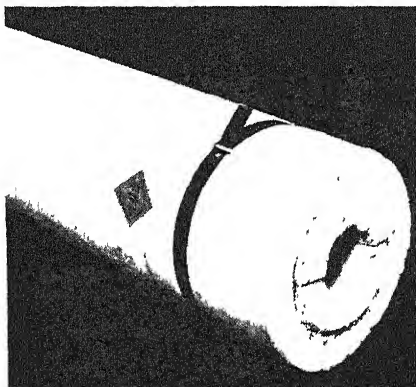
plaster of Paris mixed with sponge was tried—the small entrapped dead air cells of the porous sponge being a fairly good insulating substance—but the plaster rusted the pipes and boilers. Other insulating materials were also used and found unsatisfactory in that they shrank, charred, would not resist vibration, or otherwise deteriorated in use.

CARBONATE OF MAGNESIA ---

Sixty years ago, Hiram N. Hanmore of Philadelphia, discovered the heat insulating qualities of magnesia, an inorganic, inert, chemical compound known commercially as block magnesia and pharmaceutically as magnesia alba. It is produced from dolomite rock and its composition is somewhat indefinite, but is usually

In 1887, the U S Navy realized the value of carbonate of magnesia as an insulating material and in ordering it specified "85 percent magnesia", since that time the same phrase has become standard. Light in weight—approximately 15 pounds per cubic foot—magnesia is easily sawed or cut, withstands vibration, does not char or burn, or shrink or loosen in service. Moreover, it has no corrosive action on the metal to which it is applied, and it can be removed for inspection of pipes and replaced with ease. When properly applied, it will outlast the installation which it covers. Magnesia's durability is such that it will withstand years of immersion in water and when removed can be pulverized, mixed with water, and re-used as a plastic insulating cement. Being chemically inert, exposure to most chemicals and chemical fumes has no harmful effect, while its compressive strength allows it to be molded into many conveniently shaped forms which do not sag, buckle, or shrink.

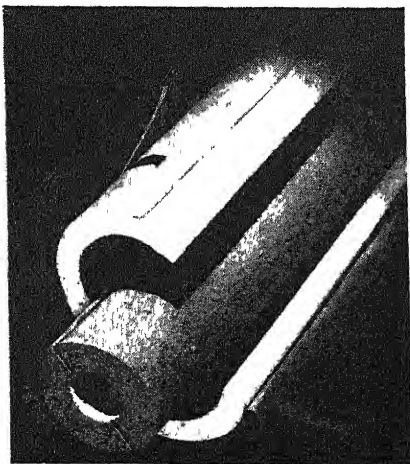
For general industrial applications, magnesia is manufactured in standard three foot long half-sec-



Courtesy Keasbey and Mattison Company
Inner lining protects magnesia outer sleeve from excessive temperatures

expressed by the formula $4\text{MgCO}_3 \cdot \text{MgOH} \cdot 5\text{H}_2\text{O}$.

At first, silk fibers were used as a binder, but silk was soon discarded in favor of asbestos fibers. Experimentation and use quickly evolved a satisfactory working ratio of 15 percent asbestos fiber binding and 85 percent magnesia, although magnesia can be and is used with a lower percentage of asbestos fibers.



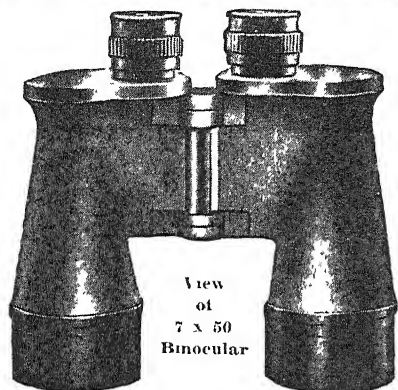
Seams are sealed by 90-degree overlap



Telescopic installation of dual-layers

SENSATIONAL WAR BARGAINS in LENSES and PRISMS

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Consisting of two Achromatic Lenses and two Convex Eye Piece Lenses which you can use to make a 41 Power Pocket Microscope, or 140 Power Regular Size Microscope. These color corrected Lenses will give you excellent definition.

Stock No. 1052-S \$3.00 Postpaid

Consisting of Prism, Mirror and Condensing Lens. These used together with Stock No. 1052-S will make an excellent Microprojector enabling you to get screen magnification of 400 to 1000 Power according to screen distance.

Stock No. 1038-S \$2.00 Postpaid

BIG DOUBLE CONVEX LENS—74 mm diam, 9" mm F.L. Weighs 9 oz. Made of borosilicate Crown Optical Glass. Used as spotlight Lens, Condenser Lens, etc.

Stock No. 1048-S \$1.50 Postpaid

BIG DOUBLE CONCAVE LENS—74 mm diam 110 mm F.L. Made of extra dense Flint. Used as reducing Lens, for trick photography, etc.

Stock No. 1049-S \$1.00 Postpaid

OPTICS FROM 4-POWER PANORAMIC TELESCOPE

Excellent condition. Consists of Objective Prism Dove Prism, Achromatic Objective Lens, Amici Roof Prism, Eye Lens Set (..... \$60.00 value).

Stock No. 5016-S \$6.00 Postpaid

LENS CLEANING TISSUE—In spite of paper shortage, we offer an exceptional bargain in first quality Lens Cleaning Tissue. You get 3 to 4 times as much tissue as when you buy in the ordinary small booklet. One ream—480 sheets—size 7½" x 10½".

Stock No. 704-S \$1.50 Postpaid

MAGNIFIER SET—5 magnifying Lenses—Power from 1 to 10.

Stock No. 1026-S \$2.00 Postpaid

RAW OPTICAL GLASS

An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint glass (see orders) in varying stages of processing. Many prime blanks.

Stock No. 703-S—8 lbs (min wt)—\$5.00 Postpaid

Stock No. 702-S—1½ lbs \$1.00 Postpaid

MISCELLANEOUS ITEMS

Stock No. Item Price

3022-S—Round Wedge, 65 mm Diam \$5.00

3021-S—Amici Roof Prism (3rd grade) 2

16-S—Level Vial, 48 mm long2

TANK PRISM

PLAIN OR SILVERED TANK PRISM—90-45-45 deg 5½" long, 2½" wide, finely ground and polished. Would normally retail from \$24 to \$30 each. Stock No. 3005-S (Plain Prism) or Stock No. 3004-S (Silvered) \$2.00 each Postpaid. **FOUR TANK PRISMS**—Special—\$7.00 Postpaid.

TANK PERISCOPE

Complete Set Mounted Components—Rugged, strong, originally constructed to U.S. Tank Corps. Consists of 2 fine Periscope Mirrors, mounted in metal and plastic. Perfect condition. Would normally retail at \$10 to \$50. Stock No. 700-S \$2.00 Complete Set Postpaid.

SPECIALS IN LENS SETS

Set #1-S—"Our Advertising Special"—15 Lenses for \$1.60 Postpaid, plus 10-page idea booklet. For copying, **ULTRA CLOSE-UP SHOTS**, macrophotography, experimental optics, magnifying and for making a two power f/16 Telephoto Lens, "Dummy Camera," Kodachrome viewer, **DETACHABLE REFLEX VIEW-FINDER** for 35 mm cameras, stereoscopic viewer, ground glass and enlarging focusing aids, **TELESCOPES**, low Power Microscopes and for many other uses.

NEW 50-PAGE IDEA BOOK "FUN WITH CHIPPED EDGE LENSES"

Contains wide variety of projects and fully covers the fascinating uses of all Lenses in sets listed above only \$1.00 Postpaid.

35 MM. KODACHROME PROJECTING LENS SET—Consists of Achromatic Lens for projecting, plus a Condensing Lens and piece of Heat Absorbing Glass with directions.

Stock No. 4025-S \$1.95 Postpaid
SPECTROSCOPE SETS—These sets contain all Lenses and Prisms you need to make a Spectroscope plus **FREE** 15-page Instruction Booklet.

Stock No. 1500-S—Hand Type Spectroscope \$3.45 Postpaid

Stock No. 1501-S—Laboratory Type Spectroscope \$6.50 Postpaid

**ALL THE LENSES YOU NEED TO
MAKE YOUR OWN TELESCOPE!**

ALL ARE ACHROMATIC LENSES

GALILEAN TYPE—Simplest to make but has narrow Field of View.

Stock #5018-S—4 Power Telescope \$1.25 Postpaid

Stock #5004-S—Small 2 Power Pocket Scope \$1.00 Postpaid

PRISM TELESCOPES—Uses Prism instead of Lenses to Erect Image and are much shorter than Terrestrial Type. Have wide field of view.

Stock #5010-S—6 Power Telescope \$3.00 Postpaid

Stock #5012-S—20 Power Telescope 7.25 Postpaid

REMARKABLE VALUE!

**\$141.01 WORTH OF
PERFECT LENSES
FOR ONLY \$10**

Complete System from Artillery Scope (5X) 9 Lenses low reflection coated, absolutely Perfect. Diameters range from 1 1/3 inches to 2 1/5 inches. Used for making Telescopes and hundreds of other uses.

Stock #5019-S \$10.00 Postpaid

ACHROMATIC LENSES

Stock No.	Dia. in mm.	F.L. in mm.	Price
6158-S*	18	80	\$1.00
6159-S	23	51	1.25
6161-S	24	48	1.25
6162-S	25	122	1.25
6164-S*	26	104	80
6165-S	27	185	1.00
6166-S	29	54	1.25
6168-S	29	76	1.25
6169-S	31	122	1.25
6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S	39	63	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25

*ASTERISKED ITEMS are unmounted, but **FREE** cement and Directions included with unmounted sets. **USES**—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Macro-photography, Gadgets, Optical Instruments, etc., etc.

CLEANING BRUSH SET—For Lenses, Optical instruments, etc. Perfect quality—12 inch flexible Plastic handle, hollow circular constr. Range from stiff to very soft. 4 Brushes to set.

Stock No. 504-S—(Reg. \$6.00 value) Price \$1.00

RIGHT ANGLE PRISM—Flint Optical Glass, size 41 mm by 91 mm by 64 mm. Use in front of camera Lens to take pictures to right or left while pointing camera straight ahead. Also used in front of camera Lens to reverse image in direct positive work. Two of these Prisms will make an erecting system for a Telescope.

Stock No. 3076-S \$3.00 Postpaid

TELESCOPE EYE PIECE SET—Consists of perfect Eye Lens Set from a Govt. Telescope. Diam 1 inch, Focal Length 1 inch.

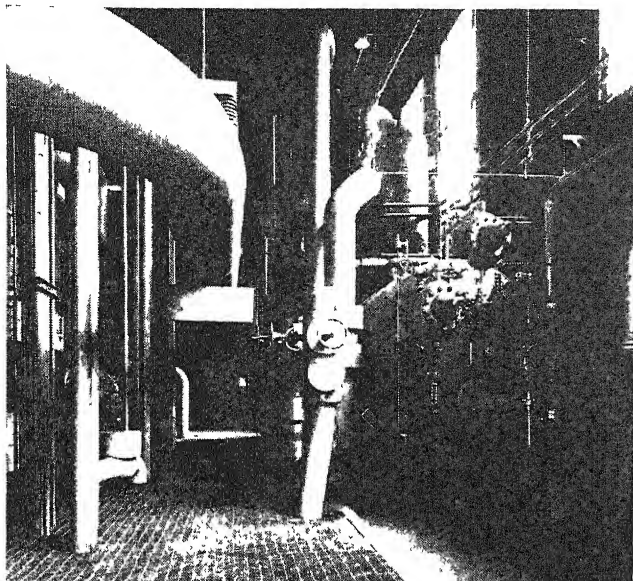
Stock No. 6144-S \$1.00 Postpaid

PRISMS

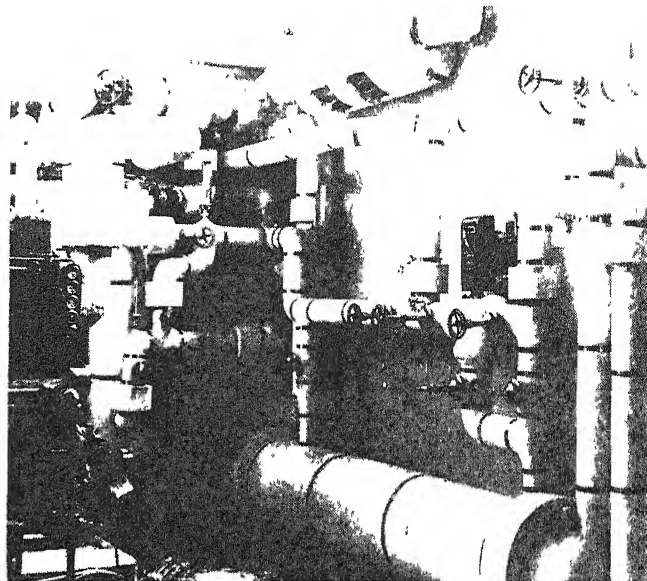
Stock No.	Type	Base Width	Base Length	Price
3040-S	Right Angle	33 mm	23 mm	\$1.00
3045-S	Right Angle	70 mm	168 mm	8.00
3001-S	Lens Surface	20 mm	14 mm	2.00
3006-S	Porro-Abbe	9 mm	9 mm	.25
3009-S	Porro	52 mm	25 mm	1.00
3010-S	Porro	43 mm	21 mm	.50
3016-S	Pentagon	45 mm	22 mm	.75
3029-S	Dove	16 mm	65 mm	1.25
3036-S	80 Degree Roof	60 mm	36 mm	4.00
3049-S	Right Angle	69 mm	167 mm	10.00
3047-S	Right Angle	53 mm	103 mm	4.00
3038-S	Roof Prism	18 mm	34 mm	2.50

Order by Set or Stock No. — Satisfaction Guaranteed — Immediate Delivery

EDMUND SALVAGE COMPANY • P.O. AUDUBON, NEW JERSEY



Magnesia blocks insulate these large pipes and boilers

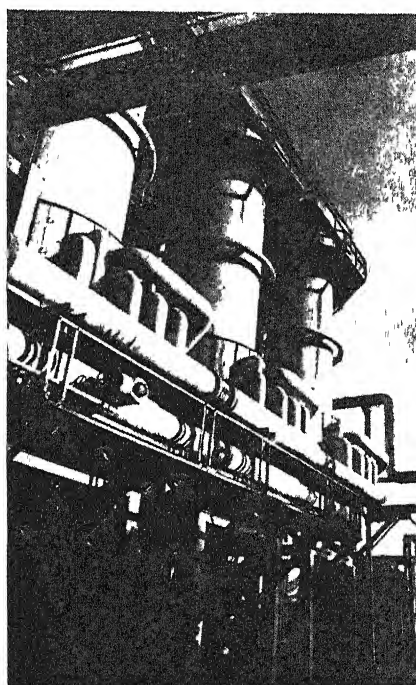


Formed magnesia sections cover complex piping neatly

tions for pipes, and in flat or curved blocks of various sizes, ranging in thickness from one to four inches. In applying multiple layers, the joining surfaces of sections are staggered to eliminate open joints and a plastic cement, made from pulverized magnesia, is used to fill in the joining areas. A canvas "jacket" is sewn tightly around the outside which is usually painted. Metal bands secure the insulation firmly in position.

ABOVE 600°—Magnesia solved the problem of efficient insulation for steam and other heat installations and was universally adopted throughout the industrial world where temperatures up to 600 degrees, Fahrenheit, were maintained. It was soon found, however, that when 85 percent magnesia was used on surfaces having temperatures above 600 degrees, Fahrenheit, there was a tendency for the insulating material to calcine on the surface next to the source of heat. This calcination produced a thin film of magnesium oxide which was found to be an even lighter and more efficient insulating substance than the magnesium carbonate. Magnesium oxide, however, is not as strong mechanically as 85 percent magnesia, and as higher temperatures became increasingly common in industry, the demand for an insulating material which could withstand temperatures above 600 degrees, Fahrenheit, became imperative.

This problem was solved by manufacturers of heat insulation who used pre-calcined diatomaceous earth in combination with asbestos fibers. This type of insulation is referred to as "high temperature" insulation, and is capable of withstanding temperatures up to almost



Photograph by Armstrong Cork Company
Refineries require heavy insulation

2000 degrees, Fahrenheit. Like 85 percent magnesia, although somewhat heavier and more expensive, it also is manufactured in standard lengths, shapes, and sizes. In practice, this high temperature resisting diatomaceous earth material is placed in direct contact with the heated surface in thicknesses sufficient to reduce the temperature on the outside of the insulating material to a little below 600 degrees, Fahrenheit. Another layer of 85 percent magnesia is then applied to protect the high temperature material. The combination produces a near-perfect type of insulation.

To reduce the number of various sized sections of insulating material now made and carried in stock, some manufacturers are planning to make

all inside diameters of insulation sections the same size as the outside diameters of standard sizes of pipe

Insulation manufacturers, continually carrying on research for better and more efficient insulation materials, have used glass wool, rock wool, slag wool, corrugated asbestos, and other materials with satisfactory results under certain conditions. Even highly polished metal reflectors have been successfully employed in some cases. But in the moderate heat range, 85 percent magnesia is the basic, all around, most satisfactory insulation available to industry today.



NEW FLUORESCENT

*Lamp Gives Brighter Light,
Has Longer Life*

FLUORESCENT lighting giving brighter yet more mellow light, instant illumination, and double lamp life is reported to be possible with Safreen, a new fluorescent lamp developed by the Duro Test Corporation.

When not illuminated, the new light appears little different than any other fluorescent lamp, but, turned on, it is perceptibly brighter. Its glow—a blending of saffron with a touch of green—is restful to the eyes. Laboratory tests have demonstrated that a 40-watt Safreen produces 20 percent more light than the standard 40-watt white fluorescent and is approximately 40 percent brighter than the standard 40-watt daylight lamp.

Longer lamp life is achieved by the introduction of heavy-duty cathode which holds five times the emission coating of the standard cathode. Tests show that this cathode

increases lamp life to approximately 5000 hours—just double the 2500-hour rated life of standard fluorescent lamps

Even more important to the large user of fluorescent lighting is the fact that the new Duro Test lamp will provide instant illumination with the flick of the switch. There is no delay and no flickering. No starters are required

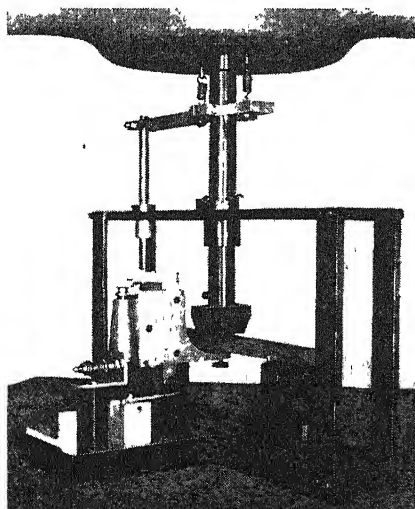
TESTING UNIT

*Obtains Data on Stiff
or Flexible Materials*

SUPPLEMENTING equipment for testing many different molded plastics, plastics laminates, and woods, the Southwark Division of the Baldwin Locomotive Works has developed a combination flexure tool and deflectometer. The new instrument will make tests in bending in accordance with the latest federal specifications and those of the A.S.T.M., and will fit any testing machine

The deflectometer measures the deflection from the center of the specimen and conveys this to an autographic stress-strain recorder which gives the load deflection curve. One of the important features of this instrument permits the operator to adjust the magnification of the deflection in multiples of 5, 10, 20, 50, 100, and 200 times. The high magnification ratio is used for very stiff and brittle materials that deform only slightly before breaking. The deflection, therefore, is measured in terms of thousandths of an inch. The low magnification permits recording large deflections which may be as much as two inches with very flexible materials

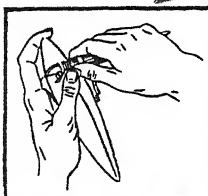
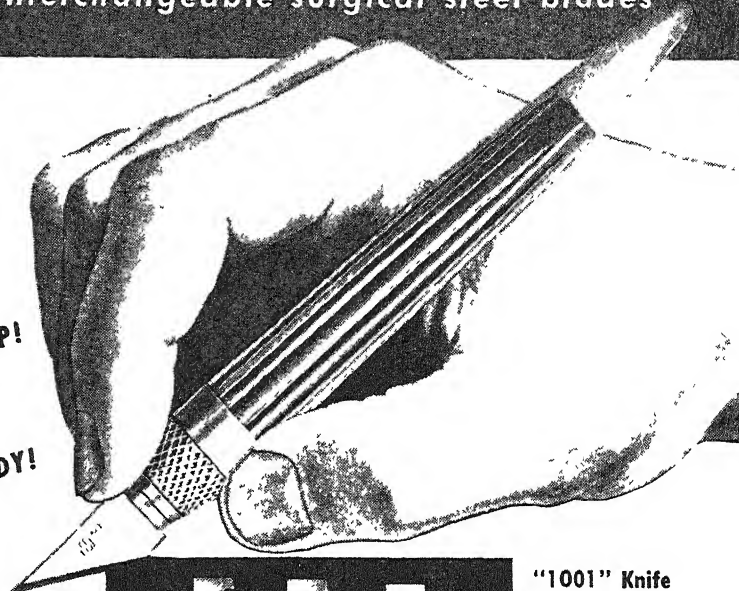
In order to obtain tension, compression, and flexure characteristics of the various plastics materials under extreme temperature conditions,



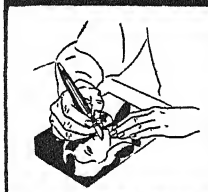
Specimen under test in new combination flexure tool and deflectometer

It's 1000 to 1 you've never used a craft knife
like the **"1001" Re-Blade Knife***
with interchangeable surgical steel blades

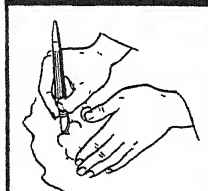
**KEEN!
EVER
SHARP!
EVER
READY!**



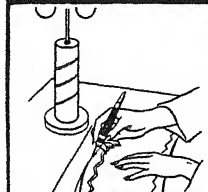
For Hobbyists



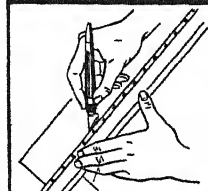
For Photographers



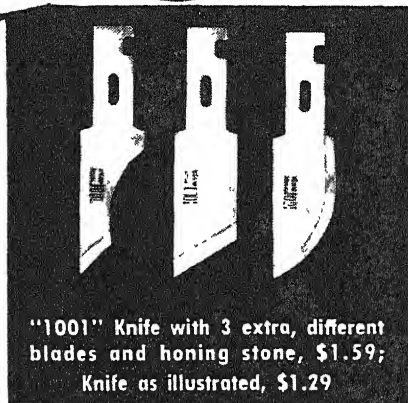
For Craftsmen



For Home Makers



For Artists



**"1001" Knife
Blades Are
Made of Finest
Surgical Steel**

Different blades for different purposes—of finest surgical steel, carefully tempered, precision ground. Designed to serve even the most painstaking craftsman.

"1001" Knife with 3 extra, different blades and honing stone, \$1.59;
Knife as illustrated, \$1.29

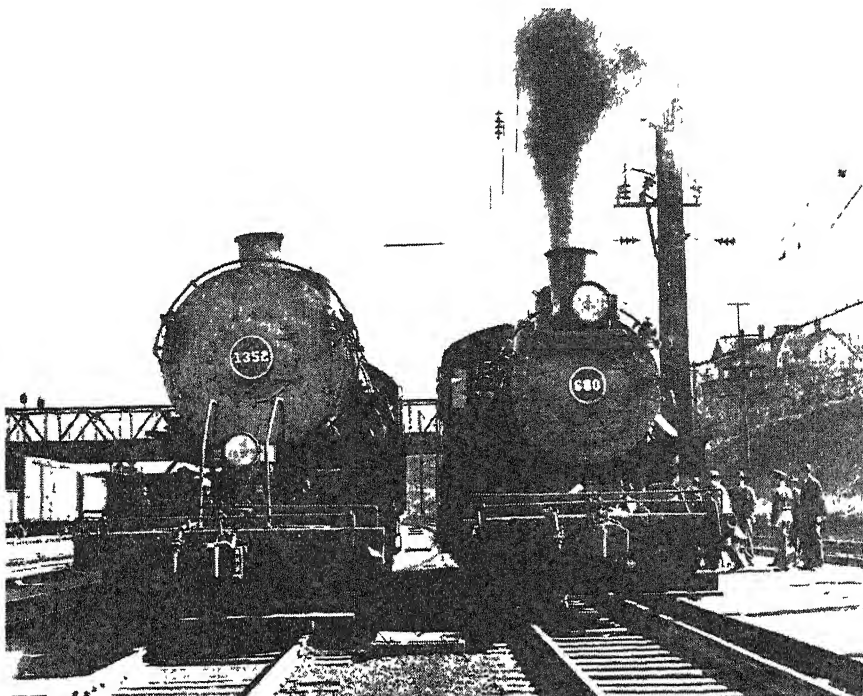
**Now — the first really "balanced"
craft knife you've been waiting for!**

Whether you're an expert craftsman or just a passably fair workman or hobbyist, you'll do better work faster and easier with "1001"—the re-blade knife of 1001 uses! For "1001", thanks to its light, perfectly balanced, colorful plastic handle, is second to none for easy and exact whittling, chiseling, modeling and cutting of all sorts. Its patented, scientifically designed chromium finish blade holder simplifies the insertion and removal of "1001's" all-purpose blades, and keeps them firmly locked in place. Which explains in large part why so many thousands of hobbyists, craftsmen, photographers, artists, home makers, etc., are singing "1001's" praises! Yourself—get a "1001"—feel the difference, see the difference in your work. It's as easy to handle as a pen or pencil.

Buy "1001" wherever hobbycraft tools are sold. If your dealer cannot supply you, send check or money order for \$1.59 (or \$1.29) direct to

SOMAR SPECIALTY CORP.
(Dept. M10) 630 Fifth Avenue, New York 20, N. Y.

*PAT. PENDING



Locomotive at left is using new over-fire air jet, one at right is not

the instrument has been designed to fit inside a cabinet in which the temperature can be controlled. The deflectometer will operate from -70 to $+170$ degrees, Fahrenheit. Since a certain ratio must be maintained between the length and thickness of the specimen under test, the span is adjustable

CELLOPHANE

*Made Moisture Proof
by New Coating*

AN INVISIBLE application of a coating so thin that 60 of the coatings, piled on top of one another, would be only as thick as a human hair, has been perfected by the Sylvania Industrial Corporation. The new application keeps moisture from passing through sheets of cellophane to which it is applied, and it is tough enough to resist breaking when the cellophane is twisted around packages. It is as clear as a pane of glass and has no odor or taste. Because

of these qualities, this moisture-proof cellophane makes a good wrapping material for foods, since it keeps them from drying out for long periods of time

LOCOMOTIVE SMOKE

*Greatly Reduced by
Over-Fire Air Jet*

ELIMINATION of all smoke from burning coal in locomotives, industrial boilers, and home heating equipment is forecast for the future by the Bituminous Coal Institute. This result is expected to come about with the universal adoption of a new principle of combustion, recently perfected.

One of the most striking demonstrations of the new development involved three locomotives, one from each of three railroads, equipped with over-fire steam-air jets at a cost of about \$110 apiece. More recently the Norfolk and Western Railroad, which has in-

stalled the over-fire jet in 182 of its locomotives, has given similar demonstrations

In five seconds an engine stack is completely cleared of black smoke by application of the jet. But, it is pointed out, the over-fire jet is not a cure-all for smoke caused by bad firing practice and equipment

The new over-fire jet is extremely simple. Jets of steam are employed to force streams of air over the fire bed. The injected air is turbulently mixed with the gases given off by the burning coal, thereby promoting combustion of those elements which normally pass up the stack as smoke. There are two essential requirements in smoke elimination—a sufficient quantity of air above the fire, and thorough mixing of that air with the volatile matter from the coal.

Earlier attempts to adapt over-fire jets to railroad locomotives were unsatisfactory, principally because there was frequent waste of steam and because the noise of their operation was objectionable to the engine crews. Both of those difficulties now have been overcome by engineers of Bituminous Coal Research, Inc., at Battelle Memorial Institute, through the perfection of an entirely new principle of design which not only increases the efficiency of the jets but also, by means of a simple and practical silence, muffles the noise.

BRAZED ENGINE

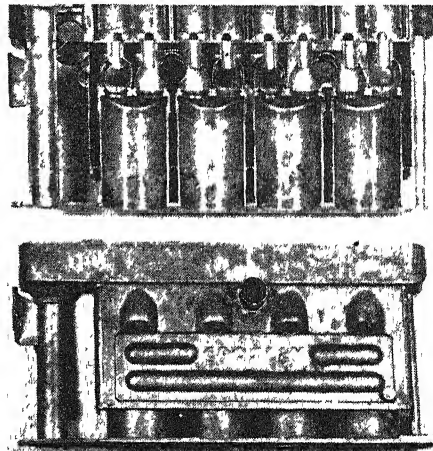
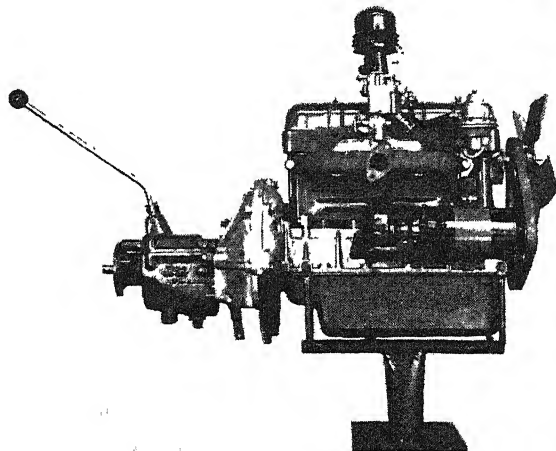
*Will Power Light-Weight
Post-War Motor Car*

STEMMING from an all steel stamped copper hydrogen brazed engine invented by Lloyd M. Taylor of Taylor Engines, Inc., the power plant of the post-war Crosley car will be a light-weight, high-compression engine of a type that has been proved in Navy service.

During the war, Crosley built engines of this type having a bore of $2\frac{1}{2}$ inches and a stroke of $2\frac{1}{4}$

The complete Crosley car engine, with all accessories, including generator and starter, weighs 138 pounds.

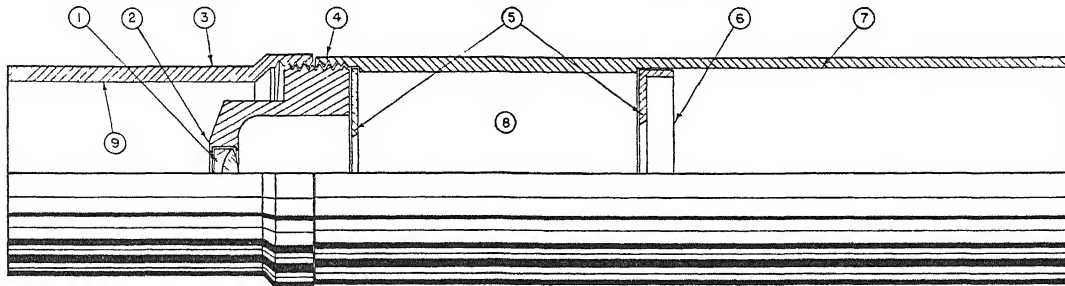
Photograph at extreme right shows (lower) the sheet-metal cylinder block and a sectional view



COATED MICROSCOPES FOR A. T. M.'s

WE are introducing a new idea, a new design, a new invaluable tool — a microscope designed for the amateur so that he may use his own eyepieces. This precision instrument can be used in every phase of optical and mechanical work. Some examples are: Inspecting optical surfaces for pits, scratches, flaws, observing machine finishes and aluminizing for any defects; and determining fits, tolerances and clearances. It has no substitute in collimation work in optical testing. Using this instrument as an eyepiece it is simple to detect in mirrors and objectives flaws such as striae, strains, decentering, poor collimation and resolution by observing diffraction patterns of artificial stars.

With a reticule in the eyepiece it can be used as a precision micrometer for mechanical layout and measuring. Truly, it is a versatile addition to your equipment. We invite your attention to the features noted on the illustration.



- (1) Aplanatic objective highly corrected for coma, spherical and chromatic aberration. B & L optical glass pitch lapped to test plates, centered and edged. Glass air surfaces COATED in accordance with Navy specifications.
- (2) Objective accurately spun into cell with jugs to insure perfect and permanent centering.
- (3) Standard 1 1/4" OD body permitting use as eyepieces and erectors in telescopes.
- (4) Simple construction to facilitate cleaning of objective.
- (5) Internal baffles to eliminate glare from unwanted oblique reflections.
- (6) Internal parts anodized where required, producing a permanent, non-scaling, non-reflecting surface.
- (7) Body will receive any standard 1 1/4" OD ocular.
- (8) Accurately machined parts of non-corroding Dural.
- (9) Removable front tube for work other than encountered as an eyepiece, such as inspection, etc.

This instrument is designed to give magnification of 50X using a 1" eyepiece. The power using any ocular is numerically equal to 50 divided by the focal length in inches. The price is \$10.50 postpaid in the U.S.A. Send your check or money order today to be assured of prompt delivery. Do not send cash.

For those who desire this fine instrument but who have no eyepieces, consult our advertisement for coated quality oculars which appeared in the February issue of this publication.

We are confident that our product will meet the most exacting requirements and therefore back every item with a refund if not satisfactory.

BRANDON SCIENTIFIC DEVELOPMENT

A New York Corporation

P. O. Box 85

Malverne, New York

inches, designed to meet Navy specifications. The displacement for the four cylinders was 44 cubic inches. The engine had to develop 28 horsepower continuously at 5000 revolutions per minute to comply with the specifications. The short stroke was selected to keep the piston speed reasonably low for this high-speed operation, and also because it was the intention to use this engine in the post-war Crosley car.

A bevel gear drive was preferred to a chain drive for the overhead camshaft, because the vertical shaft could be used to carry the lubricating oil under pressure to the five camshaft bearings. The oil pump and distributor are driven by helical spur gears from the crankshaft. The oil pump, as well as the fan, generator, and water pump, is driven at 3/4 engine speed for the car engine.

A cylinder spacing of three inches was selected, with a crankshaft bearing between each cylinder.

The outstanding feature of this engine is the construction of the cylinder block, which is made up of thin-walled alloy steel tubing for the cylinders and cam follower guides, and of sheet steel stampings for the cylinder heads, intake and exhaust ports, valve cases, and water jackets. These stampings number

about 120 pieces for one four-cylinder block. The parts are held in place by shrink fit, spot weld, or crimping operations and form a firm structure even before brazing. The entire assembly is then copper brazed in a specially constructed furnace at 2060 degrees, Fahrenheit, in a neutral atmosphere, after copper in sheet, wire, or paste form has been applied to the joints.

The inside of the water jacket is covered with a clear, hard coat of plastics which, after baking, becomes so durable that it cannot be removed in a stripping tank of a strong caustic or acid solution. The material of the jacket is 20 gage sheet steel and the sides are ribbed in such a manner that nothing detrimental occurs to the block if the water in it is frozen solid.

The crankcase is only three inches high, weighs 7 3/4 pounds, and is a permanent-mold aluminum alloy casting. The hold-down bolts for the cylinder block extend through the case to the main bearing caps. The crankshaft thrust is taken at the rear main bearings, which is the only flanged bearing. All connecting rod and shaft bearings are of the precision replaceable type and no machining is required in assembly.

In addition to the stamped

cylinder block, the crankshaft pulley, fan assembly and fan pulley, and the water pump impeller and pulley are made from copper hydrogen brazed stampings.

The cooling system holds five quarts of water and the lubricating system holds four quarts of oil, including the oil filter.

For the 1946 car engine, the mileage per gallon of gasoline, in a 1200-pound test car, with a 250-pound payload, is 50 miles at a speed of 30 miles per hour, decreasing to 35 miles at a speed of 55 miles per hour. At maximum torque, the specific fuel consumption is .48 pounds per horsepower hour. The reason for the high economy is, of course, the high compression pressure. The lack of detonation is due to the cool combustion chamber where pre-ignition is prevented during the compression. The maximum wall thickness at any point separating the combustion chamber from the cooling water is .125 inch. Because of the uniform substantially thin walls of the fabricated steel construction, including the portion between the valve seat inserts, and because of the generous contact between these walls and the cooling medium, a much more even heat distribution is obtained.

New Products and Processes

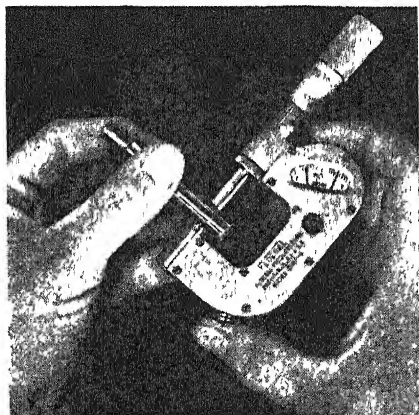
MICROMETER

*Increased in Versatility by
Use of Dial Indicator*

Just introduced by Federal Products Corporation is a new micrometer which combines the accuracy, over its full one-inch range, of the micrometer screw and the precision of the dial indicator. It can also be used as a dial indicator comparator without the necessity of setting to a master, the micrometer feature furnishes its own precision setting.

As a micrometer, the spindle can be brought in contact with the work until the indicator hand indicates "0" and the measurement is then read on the barrel and thimble.

As an indicating comparator, it can be set to the nearest thousandth of an inch, and the variation from that set-



Combines micrometer and comparator

ting can then be read on the dial. The indicating dial is integral with the frame and is provided with tolerance hands, which can be easily set with the wrench furnished with the gage. When used as a comparator, the measuring spindle is locked positively in the desired position by a thumb clamp which grips evenly, and does not throw the spindle to one side or out of line. The opposite anvil is retracted by pressure on the finger or thumb button. This enables the workpiece to be inserted with less chance of the anvils scratching the work. It also prevents excessive wear on the anvils. Both contact faces are tungsten carbide tipped, and are lapped parallel.

LIGHT PLASTICS

*Can be Compounded
With Simple Equipment*

TOUGH enough for use in making hammer heads, yet attractive enough to serve as a substitute for tile, a new

plastics is called "Plastitool," and in its natural form it looks like well-polished ivory. However, it can be dyed any color.

Developed by Duorite Plastic Industries, it can be used in making tools, art objects, household accessories, toys, bathroom fixtures, scenic casts for stage and motion picture sets, electrical insulators, water- and acid-proof vats for chemical laboratories, and so on.

Most modern plastics necessitate the use of expensive molding equipment for satisfactory results, but Plastitool could be readily handled by an average housewife with ordinary equipment.

It can be mixed like batter in a cake mixer, and it can be poured by hand into any solid mold which will produce smooth surfaces. Then it can be hardened or "cured" in a thermostatically-controlled kitchen oven.

Although it has a surface hardness which makes it comparable to the aluminum used in building airplanes, Plastitool weighs less than any of the metals now in common use and can be cut or otherwise machined like hard wood.

Secret of the new plastic is a special "catalyst," which makes it possible to harden the basic phenolic material in any given form without the use of "fillers" such as are used in manufacturing most plastics.

HAND-WRENCH

*With Vise Grip
Adjustable Jaws*

PROVIDED with a molded section of red Tenite plastics in its handle, a new wrench, which has more than a ton of gripping power in its steel jaws, has the portability of a pair of ordinary pliers, combined with the powerful locking grip of a vise, and is extremely useful as a clamp or wrench for handling awkward materials. Made by the Botnik Motor Corporation, it is designed for one-hand operation. The wrench is provided with a nut which may be adjusted by thumb and finger



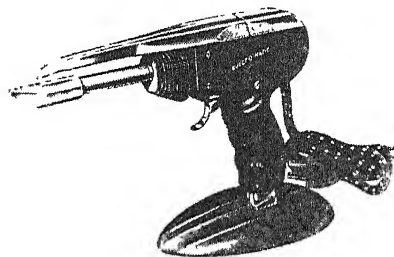
Gripping power more than a ton

to regulate the jaws, which are parallel at any opening to provide maximum gripping surface. To grip, the jaws are placed over the work, and the rounded lever snapped shut. The jaws remain locked until the lever is released. A hard-drawn steel wire spring controls the locking device.

SOLDERING IRON

*Has Automatic Feed of
Solder to Tip*

TRIGGER operated, a new automatic soldering iron ejects a measured amount of solder from a reel concealed in the handle; a special retracting feature prevents melting of excess solder on



Iron may be used on or off stand

the heating tip. The actual amount of solder deposited each time the trigger is pulled is regulated by an adjusting wheel easily accessible to the operator's thumb. If, during the course of a job, more or less solder is required, a touch of the wheel changes the amount ejected.

The Eject-O-Matic iron weighs one and a quarter pounds loaded, and is balanced so that it can be used for hours without fatigue. The non-corrosive tip is grooved to guide the molten solder to the point of application. Excess heat is dissipated before it can reach the handle.

ADHESIVE

*Exhibits High Strength When
Cured at Room Temperatures*

ANOTHER room-temperature-setting, durable resin adhesive is the most recent development in resorcin based adhesives and is another result of research by Pennsylvania Coal Products Company, which produced the earlier Penacolite adhesives G-1124 and G-1131.

The new member of the Penacolite family, G-1215, is characterized by a 3½ hour working life at 75 degrees, Fahrenheit, yet develops extremely high early strength in wood joints glued at that temperature. Strengths as high as 3000 pounds per square inch have developed in maple blocks 17 hours after gluing. When fully cured, such joint strengths may reach 4500 to 4800 pounds per square inch with complete failure of the wood. In general, this new adhesive shows outstanding strength and durability properties when cured at room temperature; when elevated temperatures are employed, considerably accelerated cures are obtained. For example, at 180 degrees,

Fahrenheit, glue line temperature, cures may be obtained in two minutes

In addition to being an excellent adhesive for wood, Penacolite G-1215 produces durable high-strength bonds with phenolic laminates and moldings, many other plastics, fabrics, leather, and rubber

COMPACT MOTORS

*Deliver Continuous
Fractional Horsepowers*

SMALL fractional-horsepower motors for industrial use, designed for optimum cooling with maximum power, are now in quantity production. Constructed for continuous duty at 125 volts, A.C. or D.C., with an output of 1/100 horsepower at approximately 7500 revolutions per minute, the motors are non-reversing, with clockwise rotation of the shaft at the fan end. As described by Lear, Incorporated, motor dimensions, with a 1/2 inch stack, are 2 1/8 inch diameter. Standard motors accommodate a 15/32 inch pulley, although special shafts or pinions may be specified.

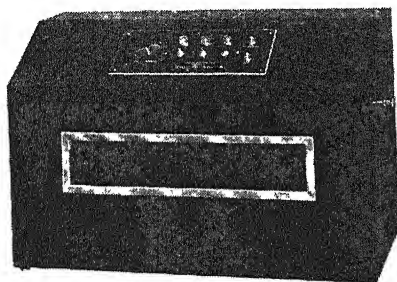
Motors rated at 125 volts, A.C. or D.C., with an output of 1/30 horsepower at 7500 revolutions per minute are also available with an overall length of 4 3/8 inches and a 3 inch diameter.

Although slanted toward the electrical appliance field, these fractional horsepowers may find application in many industries.

PHOTO COPYING

*Device Uses Green-
Sensitive Paper*

DUPLICATE photo copies of any drawing or manuscript can be made in a normally lighted room with the compact Peerless Photo-Arc Printer. This new rotary printer incorporates green fluorescent tubes as the light source.



No dark room needed—copier may be used in normally illuminated rooms

The sensitized Photo-Arc paper, transparent vellum, or cloth, on which the copies are made, is photographically sensitive to green light, but has remarkable tolerance to ordinary electric light. Thus, black and white photo copies of drawings or letters can be made right in any room or office.

The Photo-Arc Printer also employs a new mechanical method of rotary printing which is said to maintain unusually fine contact between the original and the copy.

The printer operates at a fixed speed

of six feet per minute. Variation of light intensity for different types of work is obtained by rheostat control and the choice of one, two, or three tubes.

This flexibility of light control provides for any type of copying work, making it possible to reproduce from old yellowed original drawings or blueprints, as well as from letters or even printed matter having copy on both sides.

ACID COOLERS

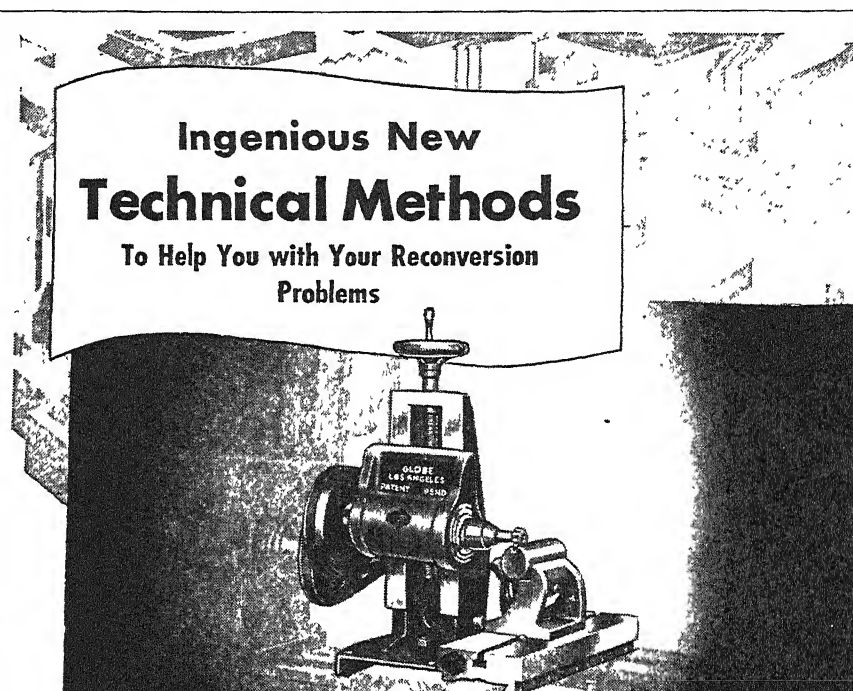
*Use Cast-Iron
Hairpin Elements*

USING experience gained during the war in producing units that cooled highly concentrated sulfuric acid from

475 to 175 degrees, Fahrenheit, or lower, in making high explosives, the National Radiator Company has developed its U-cast hairpin cooler element for peacetime applications. The new unit is used for cooling any liquid, but is especially adapted for cooling acids or strong alkalies under extreme conditions that usually result in the solutions quickly attacking other metals.

The new elements in these applications are submerged in the solution, the coolant, usually water, is passed through the element itself. The sections of the unit are cast of gray iron that is highly resistant to attack from both the solution and its fumes.

The coils formerly used in the acid cooling vats of munitions manufacturers had to be completely replaced at least every three months, resulting not only



New Unit Makes Milling Machine Out of Lathe in 3 Minutes!

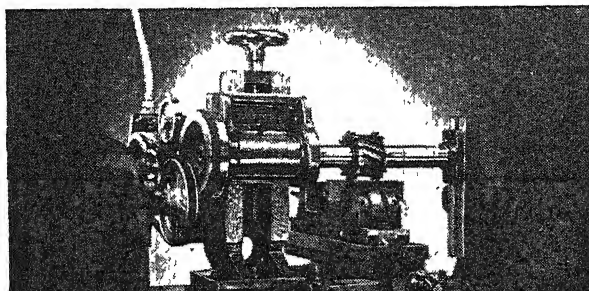
The Globe Miller, a unit quickly attached to a standard lathe, performs the same operations as a costly milling machine. Installed in 3 minutes or less, the Globe Miller operates almost identically to a standard milling machine. All controls are simple, highly accurate—and the miller is designed to utilize all speeds and feeds of the lathe.

It is accurate, durable and highly versatile. With minor adjustments and accessories, the miller will face castings; cut slots, keyways, and gears; perform slitting operations, etc. Quality materials and rugged construction enable it to

stand the hardest use. It costs but a fraction as much as a standard miller. Its compact design makes storage possible underneath the lathe. Proved performance in wartime production, assures dependable service.

Performance has also proved that chewing gum helps you on the job—by seeming to make work go easier, time go faster. Today, you'll see good chewing gum on the market. But a shortage still exists. Wrigley's Spearmint Gum is taking this space for your information, and for now, we'd like to suggest that you use any good available brand. Remember: It's the chewing that's good for you.

You can get complete information from
Globe Products Mfg. Co., 3380 Robertson Boulevard
Los Angeles 34, California

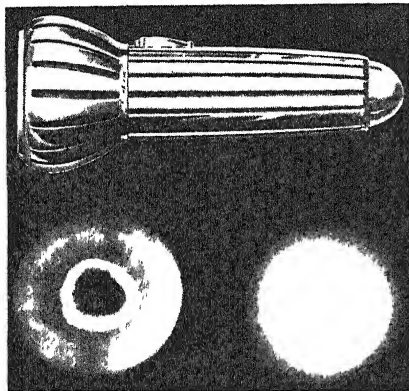


in high replacement costs, but in loss of time as well. After months of service in the same vats the cast-iron elements showed no corrosion either above or beneath the liquid line. In some cases, a small amount of sulfate deposit formed above the liquid line, but a coating of acid-resistant paint eliminated this.

REFLECTOR FACETS

Provide Solid Beam of Light

FOR USE in flashlights, searchlights, lanterns, spotlights, and floodlights of all sizes and types, a new reflector makes use of a new conception for such reflecting surfaces. In place of a smooth wall finish which causes light beams to clash with one another, this reflector, announced by General Detroit Corporation and General Pacific Corporation, has a surface broken into



Lower right: Spot from diamond type reflector; left: ordinary beam spot

multiple diamond shapes to reflect all of the light and eliminate the "dark spot" common to ordinary reflectors.

A special flashlight called "Flood-beam" incorporates the new reflector.

RUBBERIZED APRON

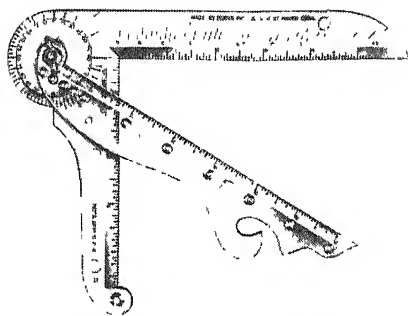
Protects Workers from Industrial Liquids

DESIGNED to give maximum protection against oil, a synthetic rubber industrial apron, which is also acid-, caustic-, and water-proof, is offered in two sizes with hemmed edges and attached neck and waist tapes. Suitable for light work in machine shops, tanneries, dairies, chemical plants, laboratories, and other applications requiring a lightweight protective garment, the Ameripol coated apron was developed by The B. F. Goodrich Company to resist nearly all industrial liquids, including gasoline and benzole.

COMBINATION SQUARE

Is Multi-Purpose Drafting Device

VIRTUALLY eight instruments in one, a new drawing and measuring device is designed and calibrated to serve as a square, dividers, protractor, triangle, ruler, compass, french curve, or miter. Called the Parva-graph, the tool con-



Reduces need for elaborate equipment

sists of two parts a combination square and a removable miter arm which can be mounted on the square through either of two mounting holes. By varying the position of the miter arm, angles of any degree can be formed, and right angle triangles can be made with acute angles of any degree desired. Removing the miter arm entirely allows its use as a radius with which circles from $\frac{1}{2}$ inch to 14 inches in diameter can be scribed. Made of tough, transparent plastics, the Parva-graph was recently introduced by Parva Products Company.

CONCRETE SCRAPER

Renovates Floors by Removing Embedded Dirt

RE-SURFACING of hard-wood floors was greatly simplified and speeded a number of years ago by the development of mechanical rotary floor scrapers and sanders. Now there has been developed a mechanical floor-scraper that does the same thing for concrete floors. The device, developed to remove embedded accumulations of dirt, oil, and chips from concrete floor in plant aisles and around machinery, is mounted on a hand truck which is just pushed around wherever the floor needs renovating.

The fact that it can re-surface a concrete floor is due to the use, on its horizontally revolving cutter, of tips of Carboloy cemented carbide, which is vastly harder than any steel and thus able to resist the abrasive wear of chips, dirt, and concrete.

SOFT FLUX

Leaves No Harmful Residue After Soldering

AN ORGANIC soft solder flux, described as more effective than common rosin fluxes, and which does not normally leave a corrosive residue on the work, is known as "Superior No 30 Super-safe Soft Solder Liquid Flux."

Because of its activity in effecting the wetting of the joining surfaces, this flux, in many cases, contributes to easier soft solderings of metal combinations which heretofore have been considered difficult to solder.

Another advantage in many soldering operations, as on electrical and radio equipment, is the absence of injurious deposit at the joint. The acid action of the flux as it comes from the container is neutralized at ordinary soldering

temperatures, when properly used, leaving a residue that is normally non-corrosive, non-conductive to electricity, non-hygroscopic, and easily soluble in water.

The manufacturer claims that if the work piece is well washed with water all corrosion-forming residues will be permanently removed.

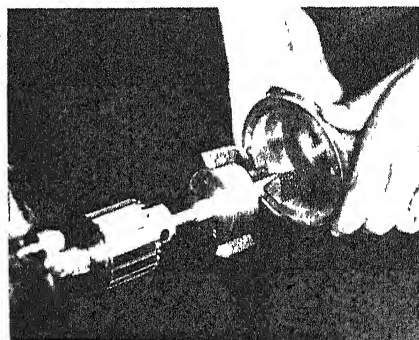
This new flux is recommended by its manufacturer particularly for applications where isin-alcohol is unsatisfactory or where zinc chloride or similar strong acid fluxes cannot be used because of the corrosion factor. It may be used in soldering copper, steel, silver, brass, various alloys, and electroplated parts.

BRUSH HOLDERS

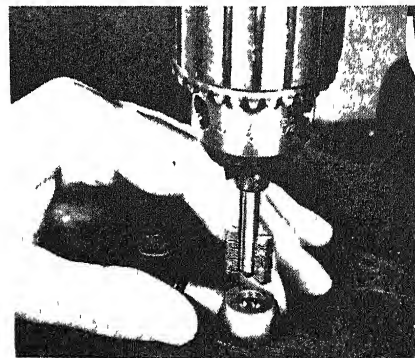
Raise Utility of Small Wire Brushes

RELATIVELY small, versatile brushes, that hold promise of easing manufacturing bottlenecks by speeding up hard-to-get-at jobs utilize the principle of wire suspension under pressure. Equipped with a variety of holding tools for use in drill presses, bench grinders, and special production and deburring tools, the crimped wire Situtt power brushes are available in a variety of sizes. Outside diameters range from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches, brush face lengths from $\frac{9}{16}$ inch to $\frac{5}{8}$ inch, stem sizes to fit $\frac{1}{16}$, $\frac{3}{32}$, and $\frac{1}{8}$ inch chucks, and overall lengths from $2\frac{1}{8}$ inches to $2\frac{1}{4}$ inches. The gage of wire used ranges from .003 to .005 inch.

Special holders, designed for these brushes, increase their adaptability and frequently permit stock brushes to be used so as to contact definite surface areas regardless of their shape. The



Above Simultaneous brushing of two inside diameters. Below. Removal of drilling burrs from intersecting holes in "hard-to-reach" spot in small part

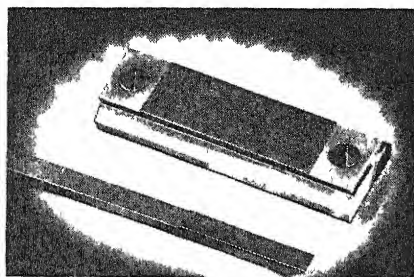


variety of applications is suggested by the range of motor speeds—500 to 25,000 revolutions per minute—recommended by the developers, The Osborn Manufacturing Company. Some typical uses for the brushes are removing insulation, rust, mold marks, and heat scale in addition to production operations requiring deburring, cleaning, or finishing small diameter inside surfaces.

FILES AND HONES

*Impregnated With Diamonds
In a Metal Bond*

DIAMOND files and hones, as produced by Wendt-Sonis Company, for dressing carbide cutting tools without removing them from the machine, contain a concentration of diamonds in a new metal bond. This bond assures that they will maintain a flat surface throughout their service life. As a result, the tools sharpened do not become "grooved." It is claimed that these diamond im-



Hones stay flat without grooving

pregnated files and hones can be used on high speed steels without loosening the diamond particles.

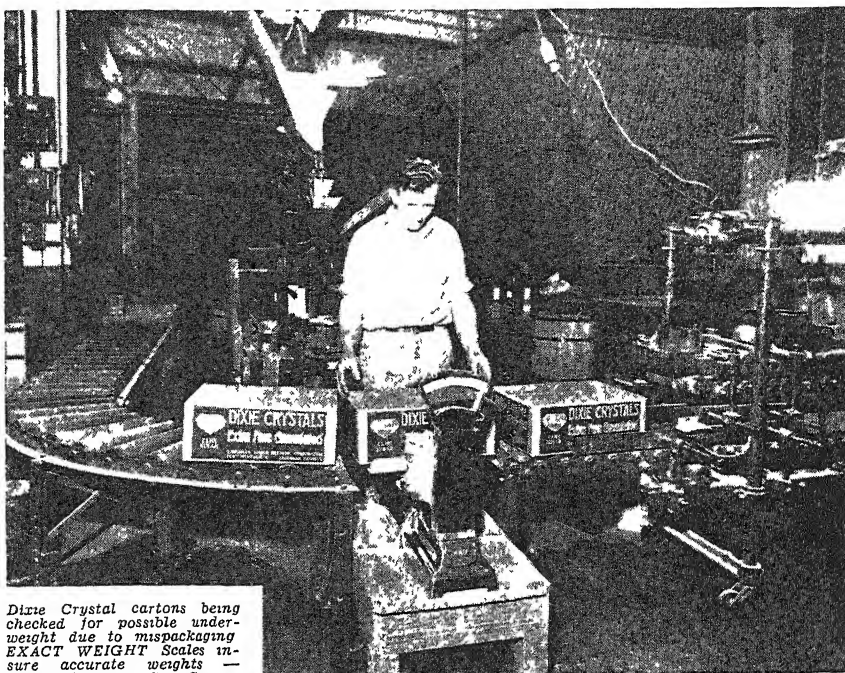
The file shank is made of drill rod stock and the hone is mounted on a lucite base.

PLASTICS LENSES

*Offer Advantages
Over Glass*

LENSES, prisms, and other optical elements of plastics instead of the customary glass, are now mass-produced by pouring fluid plastics of molasses-like consistency into precisely surfaced glass molds. An oven-baking operation then hardens the plastics which reproduce exactly the surface precision of the molds in which they are cast. When removed from their molds, the plastics elements are ready for use, without extensive polishing operations.

Unlike glass optics, the new materials and production techniques are suited for large, non-spherical optical parts, usually employed in optical systems where the light lost in transmission must be kept to a minimum. Of 140 organic plastics investigated by the Polaroid Corporation in plastics optical research, two were standardized and put into manufacture. One was methacrylate, corresponding in its optical characteristics to crown glass, and the other was polystyrene, used for elements ordinarily made from flint glass. Lenses, prisms, and mirrors from these homogenous, tough materials, although more easily scratched than glass, weigh



Dixie Crystal cartons being checked for possible underweight due to mispacking. EXACT WEIGHT Scales insure accurate weights. — Savannah Sugar Co., Savannah, Georgia

Checking Mis-packaging

Mis-packaging occurs when twenty-three consumer packages go into a carton instead of twenty-four. This condition may be due to the human element or failure of packaging machinery. The simplest and fastest way to check cartons is by pre-determined weight. When a package is missing underweight is immediately apparent; the particular carton opened and inspected. All full cartons pass over the production line untouched. Checking mis-packaging with EXACT WEIGHT Scales saves time, guarantees perfect packaging, insures accurate weights. If you package in cartons write for the catalog showing models best suited for your operation.



Exact Weight Scales

THE EXACT WEIGHT SCALE COMPANY

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only about half as much as glass and are easy to produce rapidly and in large quantities; substantially free of color, haze, and strain, and stable under extremes of temperature.

HIGH-STRENGTH MAGNETS

*Boost Performance; Lower
Power Needs of Many Devices*

MAGNET steels, including all types of "hard" and "soft" magnets, magnetic and non-magnetic alloy steels, and permanent magnets in every practicable shape and size will be available to manufacturers and engineers as the result of new manufacturing facilities added by the Allegheny Ludlum Steel Corporation.

In announcing the magnets, the company stated that the advantages to be gained in using high-strength magnets in preference to magnets of lower residual magnetism and coercive force are improvement in operating performance of equipment; reduction, or sometimes avoidance, of energizing coils and current; and reduction in size and weight of equipment, which often results in substantially reduced costs. Alnico and other strong magnets are also many times more stable than lower strength magnets under the influence of heat, vibration, stray magnetic fields, and time.

In aircraft, permanent field magnets are used on many remote-controlled motors, thus not only reducing size and weight of motors but also reducing or

eliminating the electric power required for energizing the field magnets.

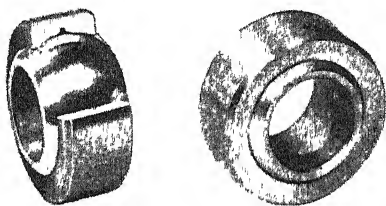
Similar advantages are gained in portable radio loud speakers and hearing aid receivers, for example, where strong magnets can be utilized to reduce the battery power required, as well as the weight and size of these products.

Although the greatest demand for "hard" permanent magnets will be by manufacturers of electrical and electronic equipment, they have become increasingly useful in non-electrical products. These now include magnetic chucks, holding devices, clamps, damping devices, clutches, magnetic separators, coin operated machines, lubricating oil filters, and so on

SPHERICAL BEARING

Meets Alinement and Rigidity Demands

A TWO-PIECE self-aligning bearing, intended to provide extremely high load capacity, a high degree of mis-alignment, and a large projected bearing area, is now being manufactured from a one piece bronze outer race into which is pressure-inserted a hard-



Steel ball rides in bronze outer race

chrome plated steel ball. The Halfco spherical bearing can be used for engine controls, aircraft, or in similar installations where alinement is costly or impossible to attain, or wherever rigidity is essential.

ENAMEL STRIPPER

Removes Various Types Of Surface Coatings

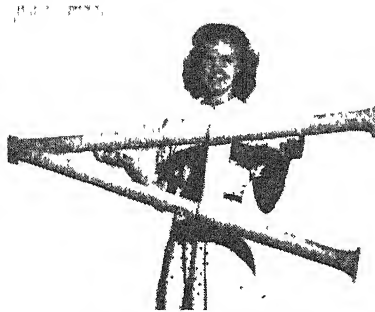
SYNTHETIC enamels such as alkyds, melamine, urea formaldehyde, and other coatings are readily stripped with Enthone Enamel Stripper S-300. The product can be used full strength at room temperature or diluted with water and the mixture heated in the temperature range of 150 to 180 degrees, Fahrenheit.

Enamels are stated to be removed cleanly by a wrinkling action, leaving the work clean and bright. There is no attack upon the base metal and such active metals as aluminum, zinc, and tin are unharmed. Phosphate and anodized coatings are not cut by this stripper.

"A" BRACE

Weighing 7½ Pounds Supports Two Tons

WEIGHING only seven and one half pounds, a new "A" shaped brace can support two tons, is chemically inert,



Bonded glass cloth brace

radio transparent, and fungus resistant. Composed of layers of glass cloth bonded by American Cyanamid Company's Laminac and manufactured by Fibremold, Inc., the brace is used in the construction of heavy radar installations. Other requirements called for in the radar brace are shock and vibration resistance and high flexural and tensile strength.

DRY-ICE LIQUEFIER

Has a Capacity Of 1000 Pounds

SOLID carbon dioxide is transformed into liquid form in a new unit developed to assist bottlers of carbonated beverages, users of carbon dioxide fire extinguishers, and other carbon dioxide consumers. Known as the "Jumbo," and developed by the Mathieson Alkali Works, the liquefier consists essentially of a tank, 80 inches high and 34 inches in diameter, made of special steel and welded throughout. It has a capacity of 20 full-sized blocks, or 1000 pounds, of dry ice. The use of uncrushed blocks of dry ice saves labor and reduces evaporation loss, it is claimed.

To charge the liquefier, the blocks of dry ice are dropped through the 15-inch circular opening at the top. It is then closed, water is run down the outside surface from a perforated ring near the top, and the liquefier is ready for operation.

In addition to its large capacity, special features claimed for the Mathieson liquefier are: absence of moving parts; long life of the special molded gasket due to the easy operation of the closure head; and operation without compressor and refrigeration unit, electric heating coils, or sensitive control equipment.

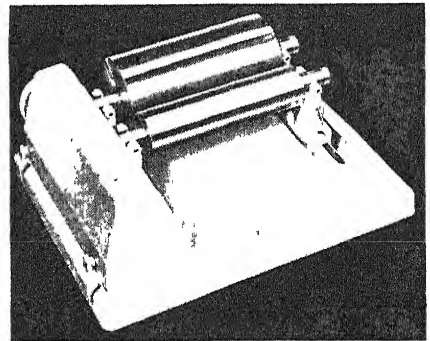
PIN LAPPING

Simplified by Two-Roller Machine

SIMPLIFYING and speeding up the heretofore slow and tedious job of lapping and polishing round plugs, pins, or rods, the "Spitfire" roller lapping machine does the job accurately and with a minimum of rejections, reportedly turning out finished jobs in approximately one third the time necessary with the old "ring lap" method. The machine consists of two precision ground cast iron rollers which revolve in self-aligning and adjustable bearings. One roller

is approximately three inches in diameter and the other roller is approximately six inches in diameter. Both rollers rotate in the same direction (away from the operator at the top of the rollers) at the same speed. They are easily adjusted to accommodate work up to six inches in diameter.

In using the Roller Lapping Machine, the most economical procedure is to grind the plug or pin within .0002 to .0004 inch of the desired size and then lap to size. Abrasive compound is placed on the rollers with the fingers or a brush and spread evenly over both surfaces. The work is placed between the rollers, then a notched fiber stick is pressed down on it and moved slowly and evenly from side to side across the



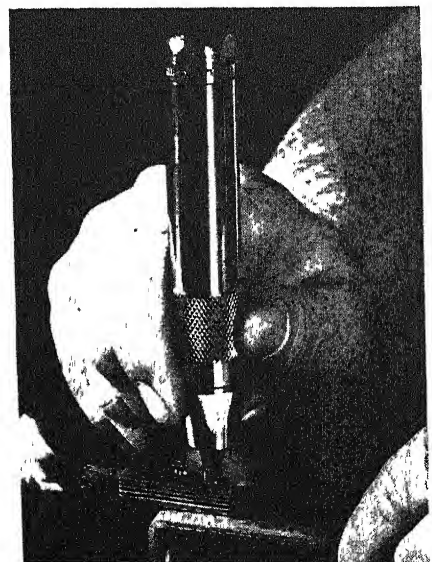
Speed-difference gives lapping action

plug or pin. If it is necessary to lap a small amount off any particular section of the plug or pin, the fibre stick is merely kept longer on that section. Friction of the rollers on the plug causes it to revolve and the difference in the surface speed of the rollers brings about a lapping or polishing action. Tapered plugs or plugs with shoulders are handled with equal ease.

POWER SCREW DRIVER

Sets Small Screws or Nuts

NEWEST addition to the Aro line of pneumatic production tools is the Midget Pneumatic Screw Driver. This tool, said to be the first power screw



Starting and stopping are automatic

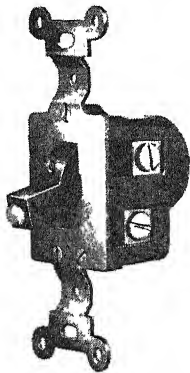
driver designed especially for driving small screws, is about the size and shape of the average cigar. Its capacity includes screws from No. 1 to No. 6. It weighs only eight ounces, is 4 7/8 inches long and 3/4 inch in diameter, and is fully automatic, it starts automatically when tool is applied to the work and adjusts itself to every driving condition.

It has a rotary four-blade motor, with ball bearings throughout, and a hardened and ground steel rotor and cylinder. This tool is also available with adapter socket for nut setting.

DELAY SWITCH

*Cuts Power or Light
After Set Interval*

A TOGGLE-LEVER all-purpose light or power switch which offers both delayed-action and instantaneous "off," plus a time-selector for the delayed action, can be set at any interval from zero to three minutes. Featuring a phosphorescent lever tip, the new switch, called Tymzit and developed by the T. J. Mudon Company, provides light for almost any interval after actual movement of the toggle to the "off" position. Yet whenever desired,



Fits standard box, has no clockwork

power or lights can be turned off instantly by a slight continuing downward push of the lever. No clockwork or electrical elements are used in the set-screw-adjusted action-delay.

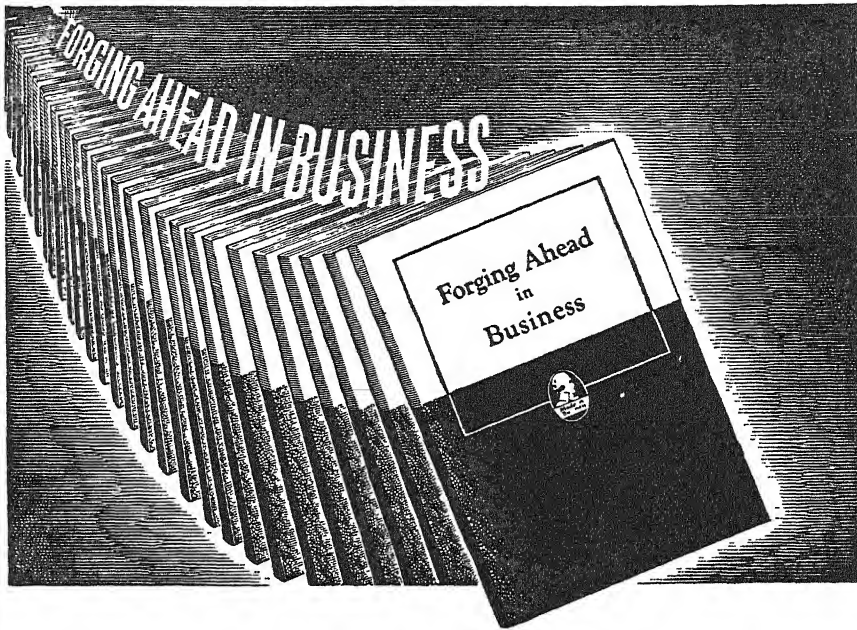
Filling a wide range of needs, the new switch could, for example, be located in the garage so as to provide time to walk into the house before the lights go off.

Described as conforming to Underwriters Laboratories specifications, the switch fits any standard wall box; is offered in single and double pole assemblies; and is rated at 10 amperes at 125 volts and 5 amperes at 250 volts.

HOOD SEALER

*Caps Bottles of
Various Sizes*

CELLOPHANE or parchment bottle hoods, printed in different colors, are sealed over the tops of both square and round milk bottles at the rate of 90 per minute by an automatic machine that incorporates a variety of mechanical improvements. Included in the developments is a star wheel which



All Serious-Minded Production Men SHOULD HAVE THIS FREE BOOKLET!

FORGING AHEAD IN BUSINESS contains a message of particular importance to production men. This is your opportunity to obtain a copy of this famous book, which has been described as a "turning point in the lives of literally thousands of men!"

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"In thirty minutes this little book gave me a clearer picture of my business future than I've ever had before."

... and that represents the opinion of

the Institute's 400,000 subscribers, including 134,000 production men!

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Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp.; and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

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Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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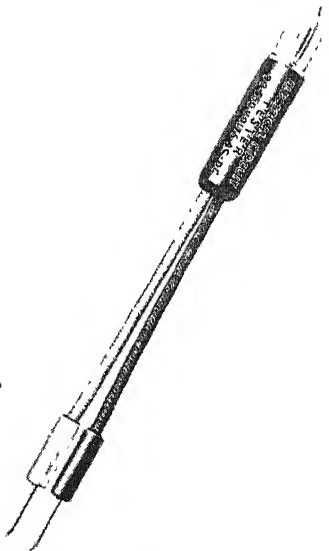
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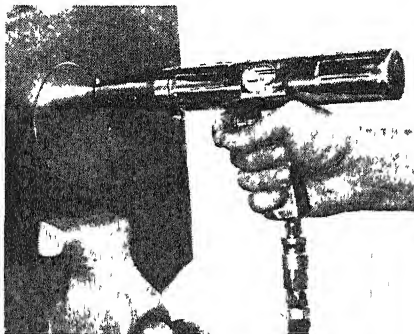
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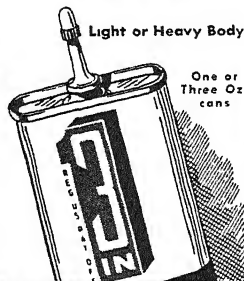
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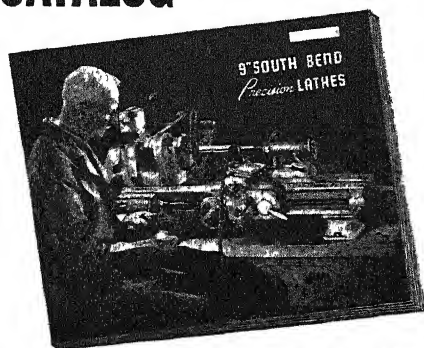
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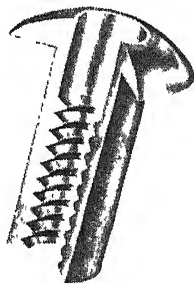
whenever moisture to a predetermined degree is absorbed by the glass tape.

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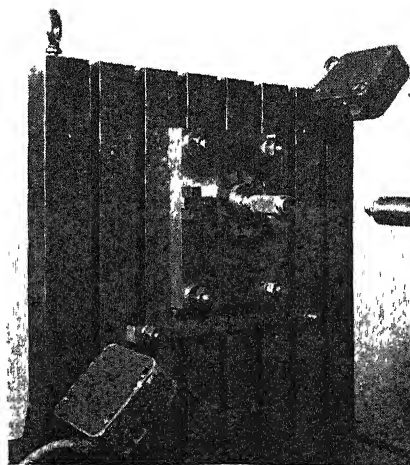
or both, is now being made in steel. Originally made only in aluminum, and then also in a brass alloy, extension to steel will allow much greater utilization of the product. The aluminum Rivnut, as it is called, was initially used for airplane industry applications, but the field has been broadened to include many other services.

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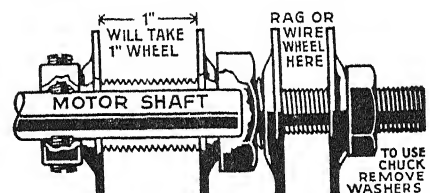
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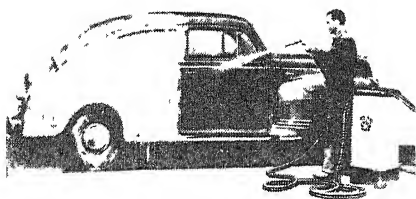
3/4 inch holes on the main shaft, or 1/2 inch holes on the small end, can also be used for rag or wire wheels, circular saw blades, or 1/2 inch 24-thread drill chucks.

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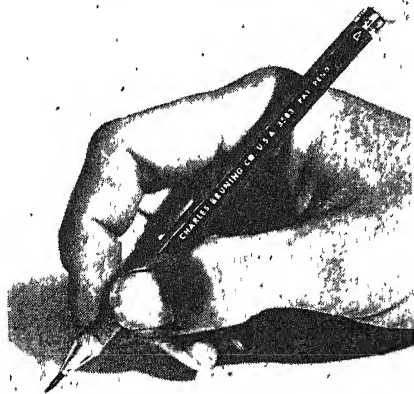
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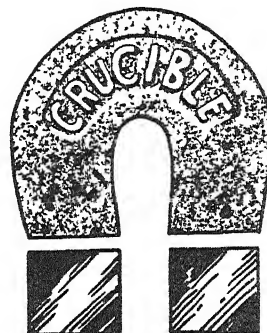
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EVERYDAY PLASTICS, a 32-page consumer guide, tells the story of the plastics industry. Simply written, it tells what plastics are, how they are made, and for what they may be used. *Modern Plastics Magazine, 122 East 42nd Street, New York 17, New York.—Gratis.*

FOREST PRODUCTS RESEARCH GUIDE. Aimed at coordinating forest products research, this 142-page catalog lists 460 types of fundamental and applied research. Types of investigations are described and the names and addresses of individuals and organizations conducting them are given. Foreign agencies are also listed. *American Forest Products Industries, Inc., 1319 18th Street, N. W., Washington 6, D. C.—\$2.00.*

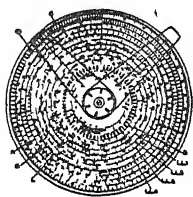
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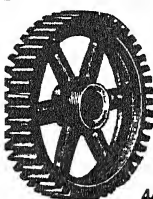
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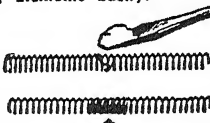
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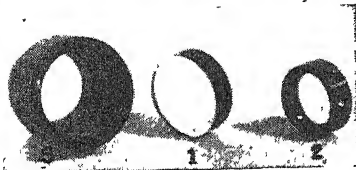
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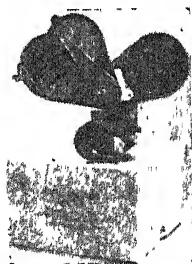
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NOT, as a reader once assumed in a letter, merely to tickle the vanity of their builders, have descriptions of telescopes made by readers of this department and of the two "A.T.M." books been published for years in this department, but because such descriptions offer original or interesting design features from which other builders may glean practical ideas. An advanced amateur (H.P.) recently wrote this department: "Looking back, my biggest help has been from the close study of a wide variety of clear photographs of other amateurs' work." Another amateur (S.L.) writes, "I like a plentiful supply of new ideas, wrinkles, and descriptions of all kinds, with many photographs." And W.W., whose telescope was described in this department last month, writes: "During its construction I often thought how helpful it would have been to have seen a collection

of the wooden pulley J of required size, simply by turning it down to that size on a lathe." Williams' drive might most aptly be characterized as (1) made from odd gears and elements picked up around home rather than sent away for, and (2) inexpensive.

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B is the control cable leading to the hand Switch at end

C, motor, 3500 r.p.m., Dayton Electric Co., Chicago

D, back gear. Reduces speed to 1/2 r.p.m.

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F, leather coupling

G, 2-to-1 spur gears from an old mag-neto

H, 2.2-to-1 spur gears The smaller of these is behind and attached to the larger gear at G.

I, worm gear, 50-to-1 From an old airplane carburetor.

J, drive pulley (wooden) turned to the size which gives final desired speed.

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L, idler pulleys to carry steel tape around the roller bearings, M, which carry the expanded polar axis These are held in tension by means of a spiral spring attached to the respective pivoted arms which carry them

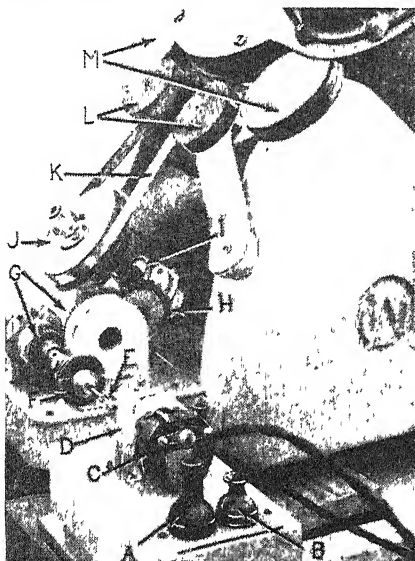


Figure 1: Inexpensive telescope drive

of photographs of instruments as built by other amateurs. I have wondered whether there might not be a place for a book containing reprints of such descriptions, from other numbers of 'Telescoptics' than I have seen, so that the various ingenuities could suggest possibilities to those who were in the process of planning"

"W.W." is Warner Williams, Culver, Indiana, and at our suggestion he has now prepared a close-up photograph (Figure 1) of the driving mechanism of his telescope. "For the amateur," he writes, "this type of drive seems ideal because it does not require special cut gears to obtain a precise speed, this being taken care of through the ability to choose any desired speed by making

THOUGH at first glance the telescope shown in Figure 2, made by Arthur W. Sear, 550 Windsor Ave., Stratford, Conn., appears conventional, it embodies eight interesting features to which ye ed will call attention by italicizing their key words in Sear's description, which follows "Optically, the telescope is a conventional 6", f/8 Newtonian. My son is shown posing at the ocular and is holding the *control box* in his hand The boy is nearly six feet tall, which will give a measure of the mount.

"*Detachable handles*, inserted through openings and guides, are used to wheel the telescope, wheelbarrow fashion on its 10" rubber-tired wheel, from the garage to a convenient location. Removing the handles after the telescope is adjusted eliminates the danger of tripping over them in the dark. The power cord is long enough to permit setting up the telescope in *any part of the lawn*. The mounting is not excessively heavy and has a high degree of rigidity The *leveling screws* could easily be a source of lateral wobble

but this has been prevented by having the screws push down against a sturdy A-frame which is hinged along the base of the triangle, thus giving *diagonal bracing*.

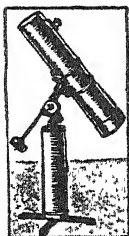
"In order to point the telescope accurately it is essential to have the polar axis properly oriented. To permit setting it up quickly I have permanently attached a small *auxiliary telescope* just above and parallel to the polar axis This auxiliary telescope has a special home-made reticule with a small circle 1° away from the center of the reticule. The offset is very nearly equal to the declination of Polaris A long-focus ocular permits insertion of a prism diagonal between reticule and eyepiece This makes for easy use without inverting the image at the reticule If the reticule sleeve is turned so that the markings on the sleeve indicate local sidereal time, it is only necessary to jog the mounting around and adjust the leveling screws until Polaris appears in the center of the offset circle The accuracy of alining the telescope by this method is perhaps within 5 minutes of arc, so that the probable error is well within practical limits Setting up the telescope requires only a couple of minutes and the method permits accurate orientation of a portable telescope.

"A type CZM Telechron motor housed in the square box drives the polar axis at sidereal time and works with negligible error through a gear combination of (51x79)/(49x82), which is equivalent to the ratio given on page 322 of 'A.T.M.A.' The polar axis drive includes a differential gear so that a small reversible motor can be switched on and off to move the telescope slowly in right ascension, for *scanning slowly over an area of the sky*, without interfering with the sidereal drive The box mounted on the declination axis contains a similar reversible motor for scanning north and south. The scanning motors drive the telescope at approximately 6° per minute This speed is a little fast for the highest power eyepieces but is perhaps a good com-



Figure 2: Sears' semi-portable mount

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Harvard Observatory, Cambridge 38, Mass.

promise when the low powers are considered. Friction clutches on both axes slip when the tube is pushed by hand from one part of the sky to another. The scanning motors are controlled by switches in a small box at the end of a 6' cable. A small electric lamp with a red lens is located in the end of the control box. This lamp is convenient when reading the scales or making notes. The red light does not seem to disturb the adaptation of the eyes to darkness.

"The floating R.A. circle sidereal drive system ('A.T.M.', page 145) simplifies the problem of finding a sky object. The right ascension circle is mounted on a sleeve that is free to turn on the polar axis. The sleeve and circle are driven through an independent worm gear at sidereal time. If the right ascension circle is once set so that its position is correct it will follow the stars as long as the power is turned on. Two pointers, 180° apart, are rigidly attached to the polar axis and are adjusted so that when the telescope is pointed straight up one of the pointers will indicate local sidereal time on the R.A. circle. Or, if the telescope is turned to any part of the sky, the pointer will indicate the R.A. of that direction.

"The oculars are individually mounted in adapters which plug into the main fixture, similar to automobile lamps. Each eyepiece is focused by sliding it in its adapter where it is clamped in place. The eyepieces can be changed quickly and they are automatically in focus when they are plugged in—parfocal is, I believe, the correct word for the arrangement. A micrometer screw on the main fixture permits the user to adjust the focus for his individual eyesight.

"The polar and declination axes run in ball-bearings. The big-end bearings are 1 1/4" in diameter, the small-end bearings approximately 3/4". The housings are of cast bronze.

"I polished and figured the mirror several times and it is as nearly perfect as I can make it. With a 1/3" eyepiece the out-of-focus rings of a bright star look very much like Figure 23 on page 429 of 'A.T.M.', excepting that the diagonal covers the center. Once, on a good night, I easily split a 1.2" double and believe that I could almost reach the theoretical limit of .75" for this sized mirror, under perfect conditions.

"The tube of the telescope does not show up well in the illustration but is quite handsome. It is a 7" inside diameter plywood tube obtained from the Plymold Corporation, Lawrence, Mass. It is light, strong, easily worked with wood-cutting tools, and has a beautiful natural wood finish. The low heat conductivity of plywood is also desirable. I installed a small door in the side of the tube near the mirror so that I can place a dust cover over the mirror when it is not in use."

SILVERING is not extinct and quite a few independent-minded users of reflecting telescopes still silver their mirrors. The old types of lacquers for protecting them did not meet with wide acceptance but now, in *The Journal of*

the British Astronomical Association (Vol 54, No. 7) F. J. Hargreaves describes experiments with a lacquering solution of Perspex, a synthetic resin plastic. This was found to be soluble in butyl acetate and excellent results were obtained with a 0.5 percent solution. The Perspex was added little by little, in finely divided form (fine filings), and stirred often to prevent agglomeration. It swells up till it occupies the whole volume of the solvent, several days being required for the solution. Attempts with amyl acetate as a solvent gave too gelatinous a solution.

The mirror was set on a phonograph turntable, flooded with the solution and kept turning until dry, the ridge of fluid at the edge being kept blotted up with a dab of blotter during rotation.

Perspex is British and, so far as is known, is not easily available in this country, but the methyl methacrylate resin Lucite is suggested as an equivalent.

Hargreaves states that the coating he obtained with Perspex had no adverse effect on mirror performance after some months. On the other hand, your scribe learns that one large American laboratory, attempting to find a lacquer for protecting silver mirrors, ran into such difficulties with black spots on the silver coating caused by the reaction of sulfur or sulfur compounds in the film-forming material used, or else in the solvent, that the investigation was abandoned. Unless there is some other answer, this seems to leave F. J. Hargreaves of England smarter than the Yankee laboratory in question, and some reader therefore may wish to appoint himself a committee of one to dig farther into the matter and report findings. There must be some lack of equivalence somewhere.

ADVERSITY has sharpened the wits of two amateurs, one a youth of 17 with a non-functional arm (polio) who made a mirror with one arm, the other who has pushed his mirror disk back and forth interminably by means of his shoulder muscles working against boards tied to his non-functional arms (polio) as stiffeners and pushers.

Several advanced amateurs recently presented the first with an RFT made jointly but still he goes ahead, one-armed making a 4" mirror because he wants to have a variety of telescopes the same as others and because he wants to succeed. Mountings are more of a problem.

One hesitates between the probably rational advice of a TN friend who has had experience with the handicapped and says it is not altogether bad for them to work out their own salvation, and the belief that dark and dusty corners the nation over must hide telescopes more or less set aside because they have been superseded by the latest loves.

INQUIRY RECEIVED—"Do you know of anyone who might care to discuss by mail the construction of a driving clock such as is described in 'A.T.M.A.' by Dr. Young (19" reflector, page 376)." — B. L. Souther, 24 Harrison Ave., New Canaan, Conn.

Scientific American

Founded 1845

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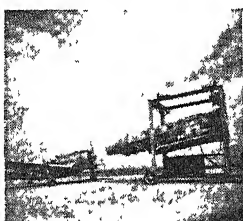
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Our Cover: A huge blower at the NACA Aircraft Engine Research Laboratory (see page 164) produces an air blast of 250 miles per hour, permits ground testing engines at maximum take-off power, and eliminates the dangers of take-offs with untried engines. It is also valuable in research on such problems as cooling of newly developed power plants.

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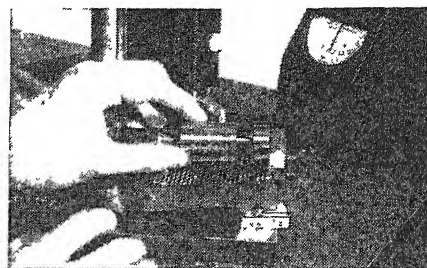
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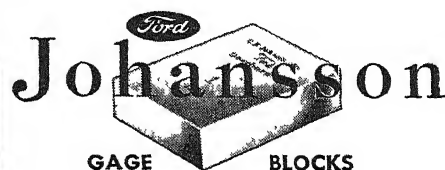


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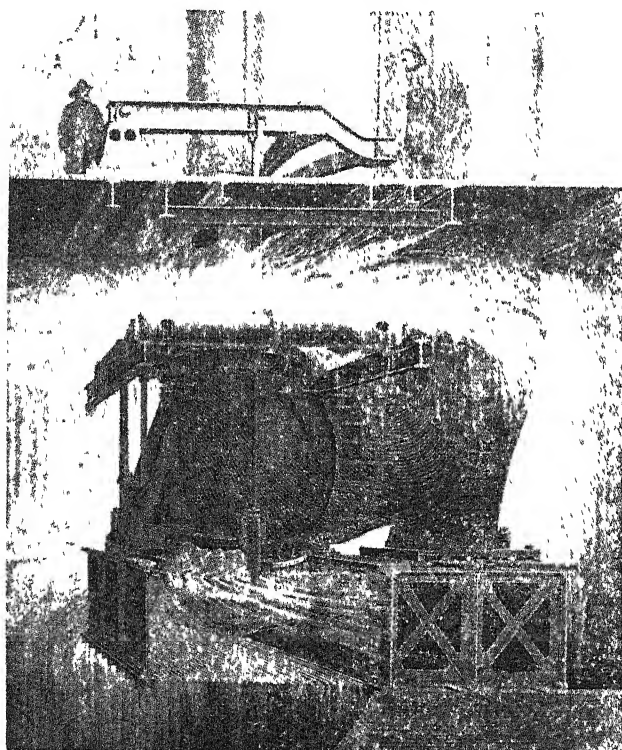
50 Years Ago in . . .



(Condensed from Issues of April, 1896)

FOCUSED X-RAYS — "The sharpness of the image obtained in photographs with a new tube for producing X-rays is due to the fact that the cathode rays are focused to a point where they impinge on a plate of platinum fixed on the anode"

NIAGARA — "From many points of view the development of the power plant at Niagara Falls is of special interest. The undertaking from its outset was conceived on original lines, and even in the purposes to which it is applied, such as the production of aluminum, of calcium carbide, and of carborundum, there are elements of novelty and interest. Below the solid floor, and directly beneath the dynamos, a great rectangular pit descends nearly two hundred feet through the solid rock. Near the bottom of this pit the 5,000



horse power turbines are established. . . The wheels are double Fourneyron horizontal turbines, one placed vertically over the other, the upper one being inverted. . . The water delivered by the penstock enters the space between the wheels, which is inclosed by a casting, constituting a sort of drum. About half of the water rises and, rushing out through the upper wheel, actuates it, while the rest of the water drives the lower wheel. . . The vertical shaft which transmits the revolutions of the wheel to the dynamo is of sheet steel riveted-up to form a tube 38 inches in diameter."

ACETYLENE — "M. H. Moissan finds that cerium carbide produced in the electric furnace yields when treated with water seventy-five per cent of acetylene, with much methane and some ethylene."

MINES — "At the greatest depth ever attained by miners in the history of the world, the mines in the vertical Red Jacket shaft of the Calumet & Hecla copper mine have recently stopped sinking at a depth of 4,900 feet, as this is

the required depth necessary for this company to reach the limit of its underground territory. Bored wells have been carried down to a greater depth, but the Red Jacket shaft is the largest and best constructed mining shaft in the world."

ANIMALS — "According to statistics published by the Department of Agriculture at Washington, the aggregate value of farm animals in the United States has declined very materially in recent years. At the present time the value of these animals is \$755,580,597 less than it was in 1893."

INVENTION — "The true standard of invention should rest upon the broad basis of public service or utility and not upon a mere nebulous idea which the inventor has failed to develop"

GAS — "The possibility of supplying cheap gas to the people is one of the live questions of the day; and it has largely sprung out of the competition between the great gas and electrical industries. Additional prominence has been given it of late by the rapidly increasing use of the gas engine, and by improvements in its design."

ALUMINUM — "According to researches of Lord Kelvin, the conductivity of pure aluminum is 68.5 per cent of that of pure copper. The usual conductivity, as given in the books, hitherto has been 56 per cent that of copper. . . As a conductor, aluminum is now about twice as costly as copper; but by the electrolytic process the price has already been reduced in eight years from 90 cents per ounce to 35 cents per pound."

AERONAUTICS — "The Boston Aeronautical Society was organized May 2, 1895. The objects of the society are to encourage experiment with aerial machines and to disseminate knowledge concerning the great problem of aerial navigation"

100 Years Ago in . . .



(Condensed from Issues of April, 1846)

STEAM ENGINES — "The extensive engine manufactory of Mr. Wm. Burdon, of Brooklyn, is probably not excelled by any establishment in the United States. Mr. Burdon has now 60 engines constructing and nearly finished, of from eight to sixty horse power."

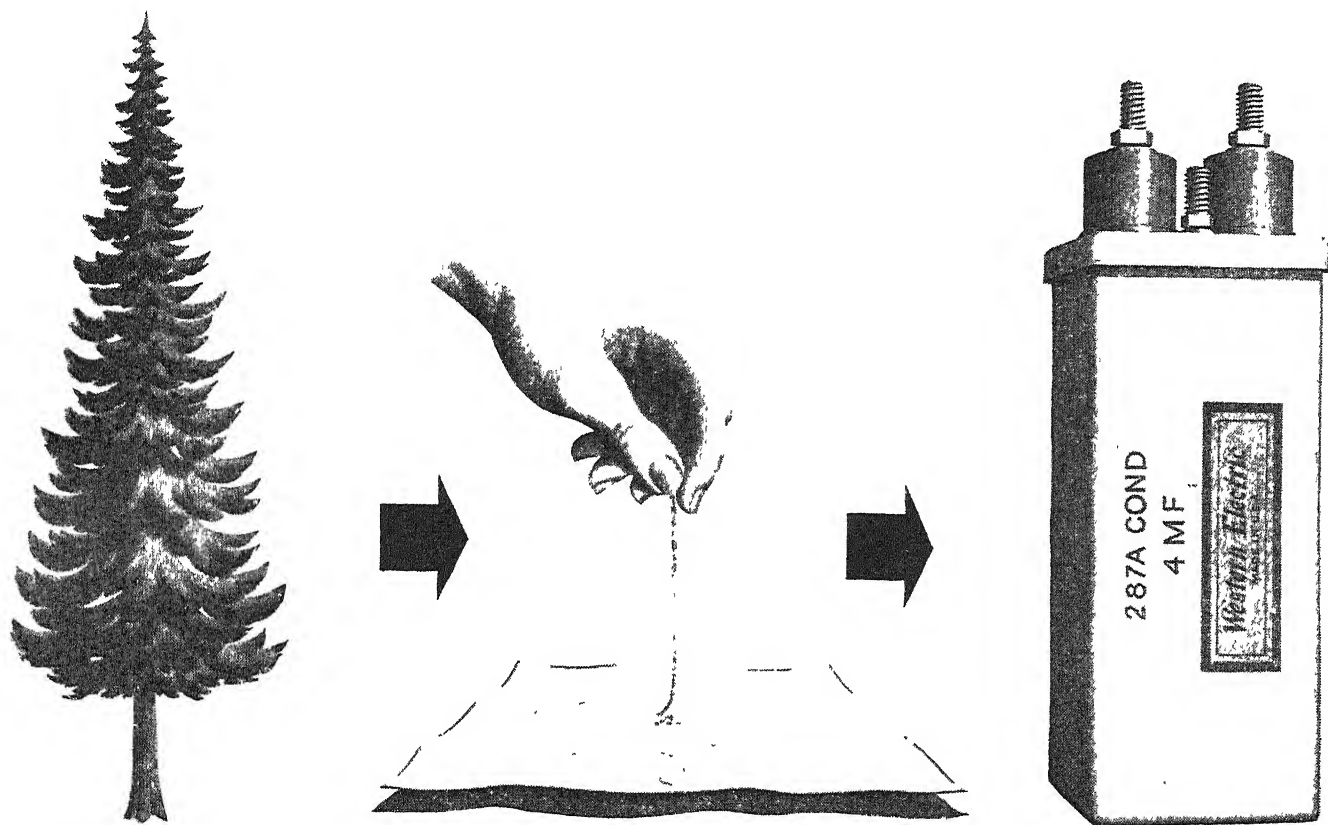
RAILROADS — "Three of the principal railroads running from Boston are now made to connect in such a manner that the cars of one road may run on to the track of another. It would afford a great accommodation to travellers if all seven of the railroads could be connected"

STEAMBOAT — "The steamboat Oregon is in length 330 feet by 35 feet width of beam, and of 1,000 tons measurement, having berth accommodations for about 600 passengers. . . The propelling power consists of an engine of 1,100 horse power, with a 72 inch cylinder and 11 feet stroke."

SALVAGE — "A party of working men are engaged with a diving bell, at New Orleans, in recovering the cargo and machinery of the steamboat Dr. Franklin."

VACUUM — "Timber of any kind, fruit or other articles may be much more rapidly and effectually dried and seasoned in vacuum, than in air."

LIFE-EXTENSION BY THE GRAM



CRUCIAL links in every wire and radio system are paper capacitors — rolls of impregnated paper and metal foil. At least one is in every telephone — and more than 100 million are in the Bell System. A single failure can sever a telephone call, put a costly line out of service. So finding out how to make capacitors stand up longer is one of the big jobs of Bell Telephone Laboratories.

All-linen paper was once the pre-eminent material. Then wood pulp was tried — and found to last longer

under heat and direct voltage. But why? Something in the wood was helping to preserve life. What was it?

Ultra-violet light, delicate micro-chemical analysis and hundreds of electrical tests gave a clue. Researchers followed it up—found the answer by treating the impregnated paper with anthraquinone—a dye intermediate. A mere pinch of the stuff prolongs capacitor life by many precious years.

When war came, great quantities of capacitors were needed for military

equipment, where failures could cost lives, lose battles. The Western Electric Company, manufacturing for the Bell System, willingly disclosed the life-preserving treatment to other manufacturers. Today in communication capacitors, the new “life-extension” is helping to give more dependable telephone service.

Day by day, resources of this great industrial laboratory are being applied to perfect the thousands of components which make up the Bell System.



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Previews of the Industrial Horizon

WRAP IT UP

MORE goods will be packaged in new, more attractive, or more practical wrappings in the near future than ever before. A number of industries have learned a lot about the mechanics of packaging in the past few years; they are finding out now that a properly packaged product will attract a greater number of purchasers than one that is offered "raw" or poorly packaged. And this applies equally well whether the wrapping serves an obvious purpose or not.

There is hardly a product of industry—from nails to hydraulic presses, from socks to shirts, from frankfurters to fresh lettuce—that is not today receiving attention from manufacturers of packaging machinery. The surface is just being scratched. Elementary to the all-inclusive problem is the axiom that packaging must not increase the final cost appreciably—or, if it does, that it must offer instantly appreciated advantages that offset any increase.

One of the fields that is now being explored is the high-speed packaging of textiles. Machines are being developed that will wrap in cellophane or similar material such things as women's and children's underwear, men's shirts, pillow-cases, and linens. Displayed in their transparent wrappings, these goods reach the consumer dust-free and unsoiled.

In pre-packaging fresh vegetables—cleaned, trimmed, and wrapped in open-face trays or simply in transparent bags—machines are reaching new highs in efficiency and ingenuity of design. So, likewise, are retail sales of the vegetables.

Operation of many of the new packaging machines is more than human. They work faster and more accurately than human hands, do not tire, and frequently do multiple jobs that could manually be done only at great expense. For example, there is a machine that will open a collapsed carton, fill it, close the lid, and pass it along for final wrapping. Another device will glue and close the tops of shipping cartons.

Competition of packaged goods is growing keener every day. And keeping at least a step ahead is the perfection of packaging machinery that operates at increasingly higher speeds and is easier to supervise and maintain.

FUN AT WORK

NO COMPANY is too large or too small to indulge with profit in that form of labor relations which provides recreation in one form or another for its workers. The program need not be as comprehensive as Eastman Kodak's, where three and a half million dollars are being spent on a recreation building for employees. It may be merely a horse-shoe pitching ground; or a game room for cards, checkers, darts, and the like; or an athletic field; or even a small theater for employee-produced plays. No matter what form it may take, it will—if properly managed—increase the interest of employees in their work, foster loyalty to the company, and frequently reveal unsuspected qualities of leadership.

ENGINES TO THE REAR

ALWAYS an advocate of breaking with tradition, when tradition stands in the way of technological progress, automotive-and-airplane-engineer William B. Stout still plumps strongly for rear-engine motor cars. Urban buses have proved the mechanical feasibility of rear-engine vehicles. Now, according to Mr. Stout, rear-engine motor cars can be produced just as soon as the public demands. Advantages of designs already made include the roominess of large vehicles, the economy of small cars, and the feasibility of using removable engines which will contribute materially to low maintenance costs.

Over a period of eight years a Stout rear-engine car has been driven some 200,000 miles. Tests have shown the

superiority of the design in such matters as traction and steering, and the advantages of a low center of gravity that go along with the rear location of the engine. These factors, coupled with the obvious possibilities of better utilization of space in the interior of the car, should make a strong bid for the public demand which Mr. Stout seems to see on the horizon.

COAL IN GAS TURBINES

PRESENT research is aiming at the use of pulverized coal—of the fineness of talcum powder—as a fuel to operate gas-turbine locomotives. If the problems involved are successfully solved, it appears possible to reduce fuel requirements to about 25 percent of the consumption of today's standard locomotives. Big drawback to the use of solid fuel in gas turbines has been the ash. Now, with finely powdered coal, burned under pressure, the resulting ash is removed by mechanical separators of the cyclone type.

If coal-burning gas turbines are perfected, as seems likely, they will have great advantages in economy and where adequate water supplies do not exist.

SOAPLESS SOAPS

SOME four billion pounds of soap are sold in the United States every year. Here is big business. But a bite is being taken out of it by "soapless soaps"—detergents that do a better job than soap and without some of soap's shortcomings. The bite is small thus far. Capacity for making the new chemical detergents is only about 100,000 pounds a year, but expansion now underway points to a possibility of producing close to 400,000 pounds annually in the not far distant future.

Big disadvantage of soap is that, while it emulsifies dirt and grease and holds them in a water suspension, it at the same time forms insoluble salts with the minerals in hard water. These salts are evidenced by the ring in the bathtub, and the difficulties of thoroughly rinsing many soap-washed materials.

The soapless-soaps, on the other hand, form soluble salts. No ring around the tub; easy rinsing of washed materials. Then, too, they are more powerful in their detergent action than ordinary soap, yet are harmless to the skin or to the materials on which used.

Although there is no foreseeable prospect that these newer detergents will ever completely replace soap, their possibilities are tremendous. Even a 10-percent bite of present soap sales will put soapless soaps in the big-business class.

FOR FUTURE REFERENCE

LOOK for more intelligent applications of existing plastics as the result of a long-range research program now underway at Massachusetts Institute of Technology; objective is a better understanding of the fundamental engineering properties of plastics. . . . New midjet batteries offer compact power source for low-current demands; they promise a mild revolution in hearing-aid and small radio field, particularly in portable transmitter-receiver units. . . . Synthetic rubber production will remain an essential peace-time industry. . . . Captain Eddie Rickenbacker offers the ingenious suggestion that atomic bombs be used to blast through the ice covering Antarctica and thus permit exploration of already proved mineral possibilities."

ENGINEERING

Quality Control Creates Jobs

By EDWIN LAIRD CADY

With an Increase in Facilities for Quality Control, Engineers Have at their Command a Powerful Tool for the Creation of More Jobs and New Industries. Materials, Methods, and Machines All Contribute



Controlled metal qualities permit contour engineering for best strength-weight ratio in aircraft engine parts

A FEW SHORT years ago the windows of certain loft buildings in New York were occupied by men who put large bolts of cloth on overhead mandrels and slowly pulled the fabric down, looking through it at the light and searching for flaws. Their job was to look for faulty quality control on the part of the weavers, although they would have told an interviewer that they were keeping flaws out of finished garments.

Garment makers made claims against the textile mills on the basis of the number of flaws found, and often shipped bolts of cloth back for credit. This led to a chain of events.

The textile mills put in thousands of loom stop motions, electrical devices which would shut off a loom instantly if a thread broke. The thread could be tied and no "run" or flaw would appear in the finished cloth. Speed controls and other flaw preventers were installed also.

Now the fabric inspectors disappeared from the windows. They were needed for other jobs, such as cutting up many layers of fabric at one time.

This multiple layer cutting came on as fast as the development of flaw elimination would let it. Given flawless cloth, a cutter could cut 20, 60, or even 100 layers at a single pass of his machine, thus produc-

ing perfect pieces for sewing. But so long as it was possible that a flaw would be found in one of the middle layers, the number of layers had to be kept down so the cost of finding and eliminating the faulty one would not be too high.

As the economies of flaw-free fabrics made themselves felt, the prices of finished garments went down until the housewife no longer could make garments as cheaply as she could buy them. But in the meantime things were going on in the textile labor situation and consequently in the national economy.

MORE JOBS—The installation of the flaw-preventing automatic devices meant that men did not have to watch the looms so carefully and one man could run more looms. Soon, 75,000 men could run the same number of looms that formerly had needed 125,000, and 50,000 men were looking for new jobs.

Now, something else was happening among the garment workers. With flaw-free cloth they could make so many garments and sell them so cheaply that their employment went up. Where in the old cloth inspection days they had employed a maximum of 60,000 workers, they now needed a minimum of 400,000. In the whole chain of production which started with the spinning and ended with the

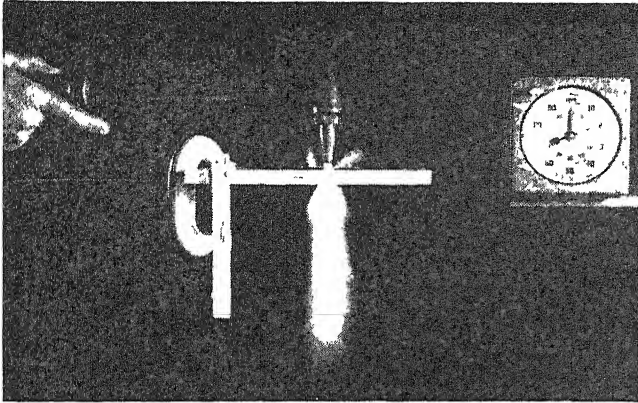
● LOOKING AHEAD ●

Strongest single force in industry is quality control . . . Better end products, at lower cost, can be obtained . . . And employment can be increased at the same time . . . Full control requires scientist-engineer co-operation . . . Product quality can be influenced by extension of new processes now available.

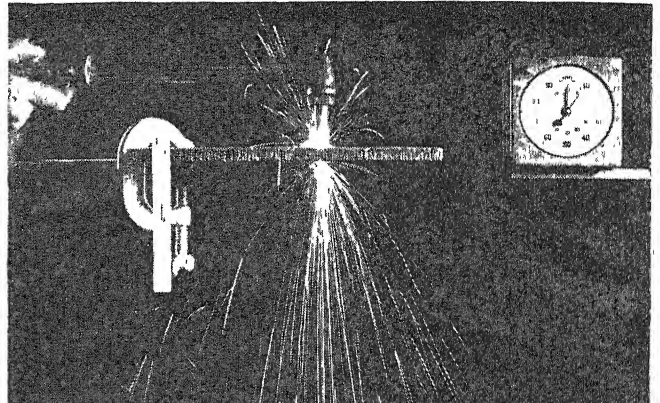
finished garments the gain in jobs was 340,000, the loss 50,000, the net gain 290,000.

Add to this the fact that the jobs in garment industry were much more highly paid than those of the loom workers, and that the distribution of those garments created tens of thousands of jobs in transportation and in retail stores alone, and the complete picture takes form of what quality control has done in one industry. There are, of course, back-ground items like the sale of thousands of electric motors and the building of huge industrial plants to make new equipment for the quality controlled industry.

One of the troubles with quality control is that it may take a long time to make its real effects apparent. Anyone discussing it is almost forced to talk about its 20-year effects in the textile industry or its 10-year effects upon the strip steel and the stamping industries. Its



An oxyacetylene torch takes twice as long to cut through a half-inch panel of wood treated with methylolurea (because of the



low heat conductivity of the material) as through a half-inch steel plate. Such known factors are important in all design

short-term effects often are confusing. And industrial managements are mostly interested in short-term, "right-now" effects.

WHAT IS "QUALITY"? — Another trouble is that although everybody knows what "quality" means, the wisest men of the centuries have been unable to define it. Aristotle toyed with it and wound up by including it as one of his categories; Cicero fumbled it like a wet football; a standard dictionary can do no better than "definitely and characteristically superior for a specific purpose;" one engineer said "a quality product has everything needed for its purpose, and in addition, is free of flaws and variants so you can trust it," another engineer said "quality control is the business of adding to the costs of your first operations in order to reduce the costs of your last ones"

Whatever the ultimate definition

of "quality" may be, quality control is the strongest single force in industry. It is the most common meeting ground of the engineer and the scientist. Far more research is devoted to problems of quality control than to finding brand new products. Atomic fission was scientifically known for years before a two billion dollar experiment in quality control made it practical.

A maker of thin gray iron castings which were to hold pneumatic pressure was faced with a quality control problem. Some of the castings had porous walls and would leak. This fault often could not be detected until several expensive machining operations had been performed on the castings, and often it did not appear until the parts were in service in the field.

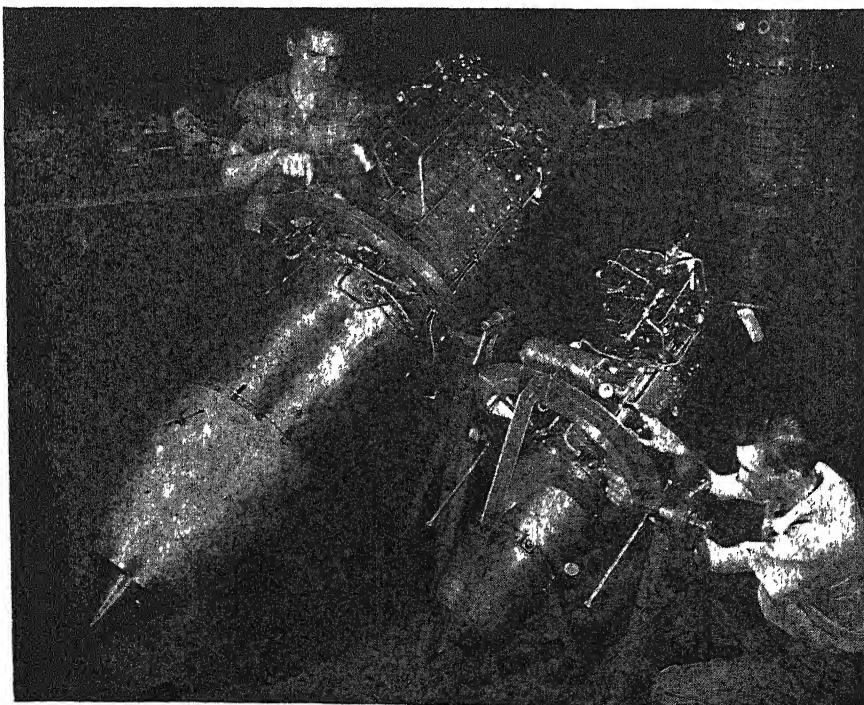
The trouble had to be stopped where it originated—at the pouring of the castings. But this was no simple matter. Before the job was

done the scientists of a great engineering school had been called in and had worked for months with the engineers of the company, and more than \$300,000 worth of new equipment had been installed. Continuous pouring cupulos had to be installed, every pound of sand had to be conditioned with complete laboratory control over the conditioning equipment, the molding had to be reduced to a production-line basis that took full advantage of the skill of the molders and minimized the human equation. The net result, as usual, was far better castings at much lower costs, but obtained only after months of development work.

INCREASED INVESTMENT—Greatly increased investments per productive man are one of the most common factors in quality control. It is not very long since \$1000 of invested capital per production-line worker was a high figure. Now \$5000 is such a common figure that only rarely can an industry having less compete on a large scale basis, and in many a plant the investment is much higher. Costs like these mean a great deal of employment for equipment designers and for the machine tools upon which equipment parts are fabricated. They also mean a great deal of elbow to elbow co-operation between the scientist and the engineer—the scientist to evolve new principles and the engineer to put them to work.

Stainless steel is another example of what happens when the scientist and the engineer work together for quality control.

When stainless steel first came out some 25 years ago, it was stainless all right but different heats of it varied so widely in their machineabilities, forgeabilities, and other workabilities that the engineer had to be in desperate need of its combined strength and corrosion resistance before he would try to



Courtesy Westinghouse Electric Corporation

Turbo-jet engines demand unusual and very specific qualities in metals used

fabricate it into his finished product Metallurgical scientists began working out specific alloys or "grades" for specific purposes; this process is still going on. One grade is highly suitable for machining and can be made into pump shafts, another can be cold formed into automobile trim, and so on through some 50 known grades.

The mill engineers worked right with the scientists. The properties and qualities of stainless steel depend largely upon how it is rolled, drawn, and processed; the labor costs per dollar's worth of stainless are comparable to those of such high precision operations as the manufacturing of ball bearings.

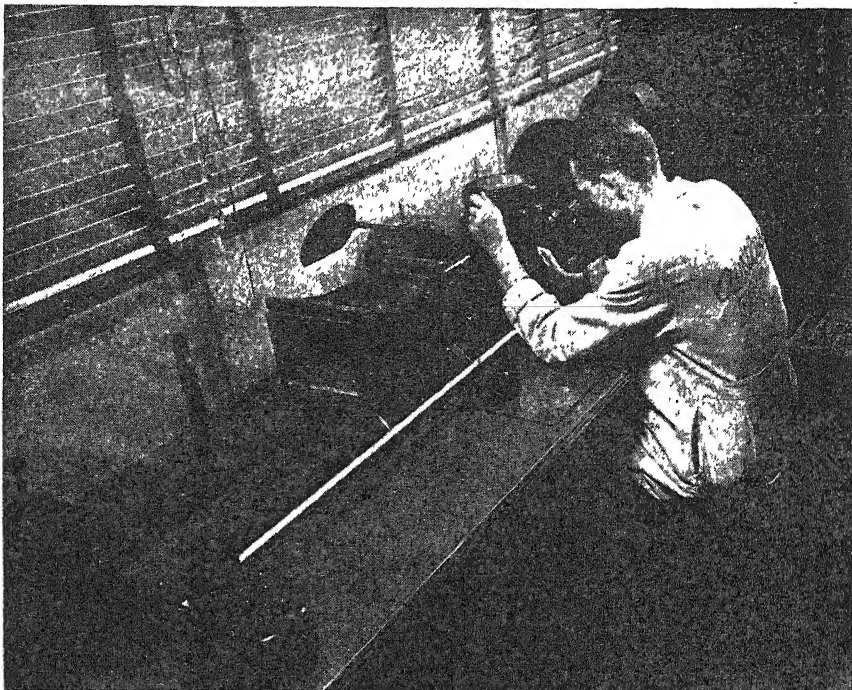
In the meantime the makers and users of machines and tools were approaching from the other end of the line. They worked with stainless steel sales engineers to develop tools, working speeds, and cutting oil formulas for fabricating stainless steels.

The large-scale use of stainless steels for quality control began to build up. With the high strength of stainless steels, sizes and weights of parts and products could be reduced while obtaining equal or greater qualities. Parts made of stainless steel would not be weakened by corrosion while in service and they were subject to little erosive wear; therefore they could be made lighter or smaller than ever before and still have superior durabilities. Quality control in the stainless steel mills is permitting fabricators to obtain improved qualities in thousands of different kinds of parts.

CONTOUR ENGINEERING — Similar quality control is being applied to dozens of different materials in an engineering science which is coming to be known as "contour engineering."

The strength and durability of a part is governed by its materials, its sizes, its accuracies, and its contours. Increase any one of those factors and the other three can go down; increase any two and the other two can go down considerably—all conditions of service being equal.

Contours other than simple ones have been the hardest of the factors to control and therefore have been able to contribute the least to the quality of the finished part. A curved or ribbed contour is stiffer than a flat one in a thin or light section; a carefully developed contour on a gear tooth will transmit more power at higher speed with less back lash and vibration—every engineer faces dozens of contour problems in the course of his work.



Courtesy Holmes I Mettee

Laboratory control of stainless steel quality ended wide variations between heats; allowed engineers to make wide use of a previously troublesome metal

Science and engineering have developed new processes such as powder metallurgy, extrusion, permanent mold casting, and precision investment casting to produce contours that never were economically practical before, and to produce them of metals and to accuracies which have the very best effects upon the qualities of the resultant products

Older or better known processes such as machining, die casting, sand casting, stamping, and forging are making rapid advances of their own

The net result is that the engineer has more facilities for quality control than ever before. And in field after field the benefits of quality control will be as great as they were in the textile industry. Quality control bids fair to do more to create jobs and build industries than any other influence.



CARBIDE DIES

*Show Great Superiority
Over Tool Steel Dies*

CEMENTED tungsten and tantalum carbides, long used in metal cutting tools and in wear resistant parts, are finding new employment in metal stamping dies.

An example reported by the New England Carbide Tool Company is a die having all cutting surfaces and all pilot pins made of solid carbide. This die cost four to five times as much as a similar tool steel one. The saving is in the reduction of lost

time of the press while dies are being sharpened, and minimizing of the need for duplicate stand-by dies so one can be used while another is being repaired.

This die punches lamination parts from silicon steel. A tool steel die would have to be resharpened after every 35,000 parts. The carbide die already has punched more than 500,000 parts—a 14 to 1 superiority in life between resharpenings—and since the carbide die is still turning out parts which are sharp, flat, accurate, and free from burrs, its final superiority before regrounding is not yet known.

GRINDING WHEELS

*Molded to Shape to
Reduce Production Costs*

GRINDING wheels having rim or side shapes formed to fit the contours of work to be ground are an old story. A new angle is that wheel makers are arranging to press the special shapes right into the rims or sides of the wheels, thus eliminating the dressing-to-shape costs to users—although the users will have to redress the wheels to restore lost contours.

Wheels having one hard and one soft side, or hard middles with soft sides, and so on, also are well known. The harder area prevents the wheel from wearing unevenly when one area of the wheel face has to do more work or to meet more severe conditions than another. Incorporation of this principle in special molded-to-shape wheels is expected to increase greatly their service between dressings.

Alloys Beat the Heat

Brand-New Alloys, and Some Old Standbys from Other Fields, are the Key Materials of Turbosuperchargers, Gas Turbines, and Jet Engines. Long Held as Top War Secrets, Their Compositions and the Methods by Which They were Formed, are Now Revealed to the Industrial World

By FRED P. PETERS

Editor-in-Chief, *Materials & Methods*

SUPER HIGH-TEMPERATURE alloys and their war-time applications to turbosupercharger, gas turbine, and jet engine construction represent a story of outstanding metallurgical achievement that is now unfolding in piece-meal fashion. It may be several months before the picture will be completed through gradual relaxation of government restrictions, and it is even likely that publicity will never overtake actual developments, for research and investigation on high-temperature problems and metals to solve them are still continuing.

INDUSTRIAL CO-OPERATION — The super-alloy project was one of the many war-time developments that were almost entirely co-opera-

tive in nature and whose final success depended on the collaboration of dozens of manufacturers, metallurgists, and engineers. The need was for materials—either metallic or non-metallic—that would withstand the continuous 1200 to 1500 degrees, Fahrenheit, temperatures required for even minimum-efficiency operation of turbo equipment. The real problem was to find alloys that could be made into precision parts that would not oxidize, rupture, nor change their shape or precise dimensions in service at the high temperatures encountered.

Both the War Metallurgy Committee, headed by Clyde Williams of Battelle Memorial Institute, and the Super-Alloys Project of the War Production Board, headed by Rus-

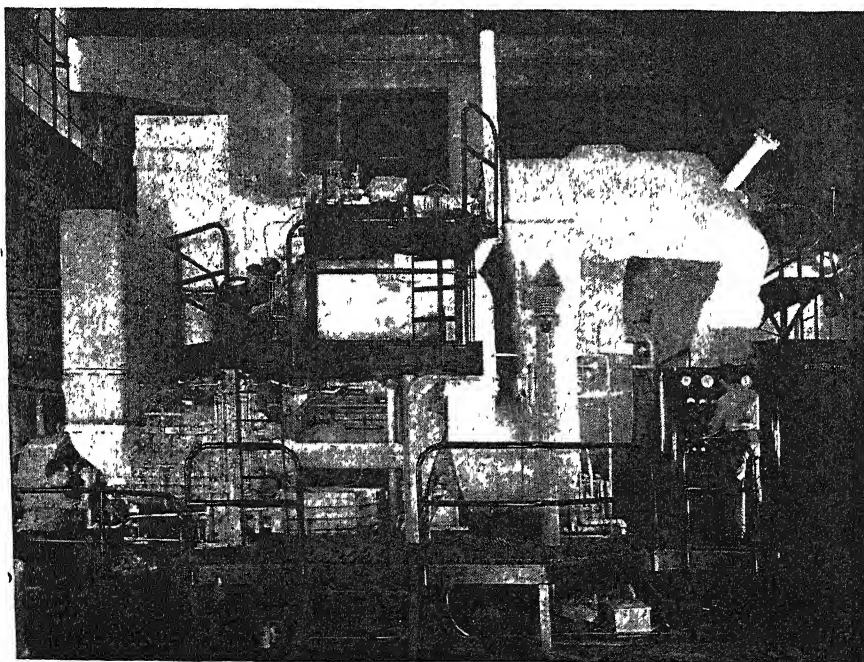
● LOOKING AHEAD ●

High-temperature alloys will find dozens of applications in the power field. Long-standing industrial problems—such as heat-treat furnace parts, oil-refinery and process industry equipment, exhaust valves, high-temperature bolting, and steam equipment in general—may be solved by use of greater quantities of the various metals than the specific applications that prompted their initial development.

sell Franks of Union Carbide and Carbon Corporation's Research Laboratories, were active nerve centers in the development. Engines were made by Westinghouse, General Electric, Allis-Chalmers, Elliott Company, and others. The special high-temperature alloys were developed or made by several manufacturers: Westinghouse, General Electric, and Allis-Chalmers precision-cast or otherwise fabricated materials and parts; Timken Roller Bearing Company, Haynes Stellite, International Nickel Company, Climax Molybdenum Company, Molybdenum Corporation of America, Allegheny-Ludlum, Rustless Iron and Steel, Austenal Laboratories, other stainless steel companies, and other precision casters all participated in the development of alloys, and many others in the manufacture of parts.

MODIFIED STAINLESS—Two types of materials emerged from this scientific attack as fundamentally best suited for ultra-high-temperature service: austenitic or ferritic stainless steels—iron-base alloys containing nickel and chromium in amounts up to 45 percent—to which molybdenum, titanium, and tungsten are added separately or in combinations; and cobalt- or nickel-base alloys containing as major alloying elements chromium and tungsten, molybdenum, nickel, or cobalt.

The two major problems of load-bearing strength and dimensional stability at high temperatures are not simultaneously solved with any



Strength and distortion resistance at 1200 to 1500 degrees, Fahrenheit, are vital requirements for hundreds of metal parts in the Elliott gas ship turbine

one alloy as yet removed from the restricted list. The modified stainless steels prove to have excellent strength at high temperatures but are not ideally stable dimensionally, whereas the cobalt-base alloys are the precise but not necessarily the strongest members of the team. In jet engine and gas turbine applications the materials are individually

combination of characteristics for this service. Details, however, have not yet been released.

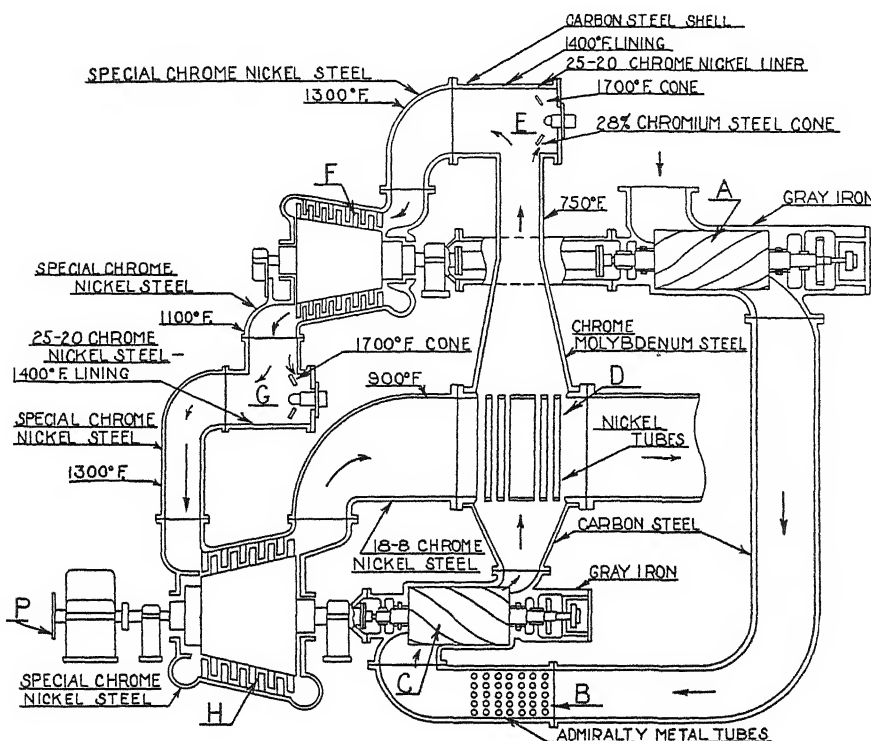
Modifications of well-established nickel-base alloys are also finding specialized uses in critical areas of jet and gas turbine units. A new variety of Inconel—Inconel “X,” 75 percent nickel, 14 percent chromium, 6 percent iron, 3 percent

percent chromium, 8 percent nickel steel, and ultimately to a special 19 percent chromium, 9 percent nickel stainless steel containing tungsten and molybdenum.

The Elliott-Lysholm gas turbine nicely exemplifies the two-way problem of meeting service requirements, while still providing a design that can be manufactured, which the materials engineer on such projects must somehow solve. Because all metallic materials “creep”—that is, they grow or deform slowly under stress at high temperatures—turbine rotors will grow, flat-sided ducts will bulge, and round ducts will grow too large and thin. These changes are inevitable, but the engineer must handle materials and loads so as to hold the changes to an absolute minimum and thus extend the life of the engine.

The best materials-and-processing set-up for the Elliott engine, as determined by its engineers, has been the use of rolled plate and arc welding wherever possible, thus fabricating many pieces into one permanent assembly. This method of construction was used on all the duct work and the combustion chambers in the Elliott engine, while the turbine rotors were machined from rolled plate and forgings, and welded into an assembly.

The extensive use of welding in assembling these high-temperature materials introduced some knotty problems. For example, S A E. 4130 steel is an air-hardening steel, so that joints had to be individually studied and checked in advance to determine whether their nature and mass were such as to require pre-heating. Again, welding of the 19 percent chromium, 9 percent nickel steel



The Elliott Lysholm gas turbine cycle—temperatures vary throughout and metals must be selected for specific uses. Large capital letters locate major parts of turbine: A, low pressure compressor, B, intercooler; C, high pressure compressor, D, regenerator, E, high pressure combustion chamber, F, high pressure turbine, G, low pressure combustion chamber; H, low pressure turbine; P, propeller

employed to use their best properties to the maximum advantage and to minimize their weaknesses

PRODUCTION PROBLEMS — In recent years many users have become familiar with Vitallium—65 percent cobalt, 30 percent chromium, 5 percent molybdenum—and the related tungsten-bearing Stellite alloys for turbosupercharger blades and similar parts of gas turbines and jet engines. Such alloys are strong, highly scale resistant, and corrosion resistant, but they are also virtually impossible to machine and forge. They were made into parts by the millions, however, by precision casting methods—“lost wax” or “investment” casting as described in *Scientific American*, December, 1945—which permitted these intricate parts to be produced directly to close tolerances without any machining. A Haynes Stellite alloy called Multimet—N-155—was developed especially for high-temperature uses in turbo equipment, and is said to offer an unusual com-

titanium, and 0.6 percent aluminum—is now used for combustion chambers. Westinghouse’s K-42-B alloy,—40 to 50 percent nickel, 20 to 30 percent cobalt, 15 to 30 percent chromium, 5 to 15 percent iron, and 1 to 4 percent titanium—originally developed for electronic tube applications, was found to be highly suitable for certain jet engine parts as well. In at least one engine—the Elliott—a special grade of pure nickel was fabricated by spinning and used for torroidal joints in the high-pressure combustion chamber inlet because of its combination of relatively low expansion coefficient and good heat resistance.

Indeed, to date, the most information about the materials used in any gas turbine has been released by the Elliott Company, builders of the Elliott-Lysholm 2500-horsepower gas turbine for the United States Navy. Their power plant runs the gamut of materials from the nickel spinings just mentioned, through S.A.E. 4130 chromium-molybdenum steel and high-grade gray iron, up to 18



Fabricating Elliott gas turbine rotor by welding together rolled plate and forgings. The special metals involved required unusual welding techniques



Dr. S. F. Moss, turbosupercharger and gas turbine expert, examines metal in heat-resistant turbine wheel of B-17 Flying Fortress turbosupercharger unit

containing tungsten and molybdenum required the development of a new welding electrode that would have the necessary high-temperature strength together with satisfactory working characteristics

NEW METALS—The newest high-temperature material of those made public to date is the 16 percent chromium, 25 percent nickel, 6 percent molybdenum steel developed by Timken Roller Bearing Company. Originally applied in the rotor wheels of airplane turbosuperchargers, this interesting alloy was later used for jet-engine impellers. In most cases the material was supplied in billet form and then forged to give the final product, although some was made available as small rounds and flats for turbine blades.

During the past four years over 12 million pounds of the 16-25-6 al-

loy have been used. The largest use was in the production of General Electric turbosupercharger wheels, hundreds of thousands of which were made from four-inch square billets of this alloy.

One of the special features of this new material is its susceptibility to precipitation hardening, which not only improves its room-temperature properties but its creep resistance as well. Actually, however, even this enhancement of properties seems small in comparison to the great high-temperature-strength advantage the ordinary annealed 16-25-6 alloy seems to have over earlier heat-resistant alloys.

Thus the stress required to produce a given rate of creep in the new material at 1500 degrees, Fahrenheit, is approximately twice that required to produce the same rate of creep in 18-8 stainless steel at 1400 degrees, Fahrenheit. In the sometimes more reliable stress-to-rupture test, 16-25-6 alloy is shown to be two and one half to three times as strong as 18-8 stainless at 1500 degrees, Fahrenheit.

The future of this material and of all the new high-temperature alloy seems bright indeed. The equipment for which they were specifically developed—gas turbines and related products—is expected to increase markedly in use, especially *if the present alloys are bettered or if they are joined by even more refractory materials.* Today these “super-super” alloys are being sought and studied, and the 1500-degree, Fahrenheit, temperatures now considered maximum for gas turbines may eventually be regarded as old-fashioned and inefficient.

verberatory furnaces producing casting ingots. Results obtained by the method are equal to or better than those achieved with chlorine gas, with the added advantages for nitrogen of low cost and non-toxicity

Bubbling the gas through molten aluminum picks up finely dispersed slag and dross and brings them to the surface where they can be skimmed off. Also, it traps the minute bubbles of air entrained in the melt and brings them to the surface, and transfers dissolved or absorbed hydrogen from the melt to the rising gas bubbles so that the hydrogen concentration is reduced to a point where it will not impair the soundness of the aluminum casting.

A slow rate of gas flow is essential to best results, according to Air Reduction Company, who have developed the technique. Tests show that the total volume of nitrogen needed is one cubic foot per 100 pounds of aluminum. For example, in fluxing an 800-pound melt 24 inches deep, a nitrogen flow rate of 24 cubic feet per hour at a pressure of two pounds per square inch is successful, the operation requiring 20 minutes. The nitrogen gas used must be dry (or “oil pumped”) for satisfactory results.

METAL POWDERS

*Now Applied as Hard Coating;
Extruded for Small Tubes*

TWO RECENT developments in powder metallurgy processing show promise of important future applications. One is the extruding of tungsten powder into very small tubing for electronic parts. The other involves a process for hard facing of powder parts. Instead of steel powders, which are often difficult to handle, iron powder is used as a base over which is applied a coating of hard material—Rockwell 72 C—by powder metallurgy methods. Thicknesses of the hard surface can be made to vary from 1/16 inch down to one ten-thousandth of an inch.

LOW-EXPANSION ALLOY

*Is Available for
Instrument Parts*

A LOW-EXPANSION alloy with a promising field for instrument parts will soon be available for general use. It is a “cobalt invar” (cobalt-chromium-iron) alloy with a coefficient of thermal expansion lower than that of quartz. Parts, cast from melted metal powders, are expected to find application in precision optical instruments, for both aircraft and industrial uses.

STAINLESS STEEL

*Age Hardens; May
be Worked “Soft”*

A NEW age-hardening stainless steel was recently announced as Stainless “W” by the United States Steel Corporation. So formulated as to be a “ferritic” rather than an “austenitic” material the new steel contains 17 percent chromium, 7 percent nickel, 0.7 percent titanium, 0.2 percent aluminum, and 0.07 percent carbon. In the annealed form it has a tensile strength of 120,000 to 150,000 pounds per square inch, and hardness of 22 to 28 Rockwell C; after precipitation hardening the tensile strength becomes 195,000 to 225,000 pounds per square inch, and the hardness 39 to 47 Rockwell C. The element chiefly responsible for the steel’s precipitation-hardening behavior is titanium—although co-

lumbium may be successfully substituted for it.

Strongly magnetic, the steel combines the strength and corrosion-resistance of conventional cold-rolled “18 and 8,” but does so without the need for prior cold-working treatment. The new stainless steel is thus similar to the strong aluminum alloys in that it can be worked in the soft state and then heat treated to achieve full strength and hardness. The new material can be produced in any cast or wrought form.

NITROGEN FLUX

*Gives Advantages in
Aluminum Casting*

NITROGEN gas is now being successfully used as a fluxing agent for molten aluminum in several foundries making high-grade aluminum castings and also as a flux in re-

'Huff Duff'

Instantaneous Direction-Finding Equipment, Perfected for Anti-Submarine Operations, Will Simplify Sea and Air Navigational Problems

By JOHN MARKUS

Associate Editor, *Electronics*

A SINGLE DOT or dash of the SOS call signifying tragedy at sea is sufficient to actuate a new high-frequency radio direction finder developed during the war by Federal Telephone and Radio Corporation. Though designed primarily to help the Navy in its battle against German submarines, the device quickly proved itself worthy of many other important applications, peaceful as well as military.

In peace, this h-f d-f (high-frequency direction-finding) system is being used to determine the positions of ships or aircraft and notify them of their location by radio; in war, it was used to locate the enemy and notify our naval forces of his location. In both cases, it gives an accurate bearing on high-frequency radio transmissions—something no

previous direction-finding system could do satisfactorily.

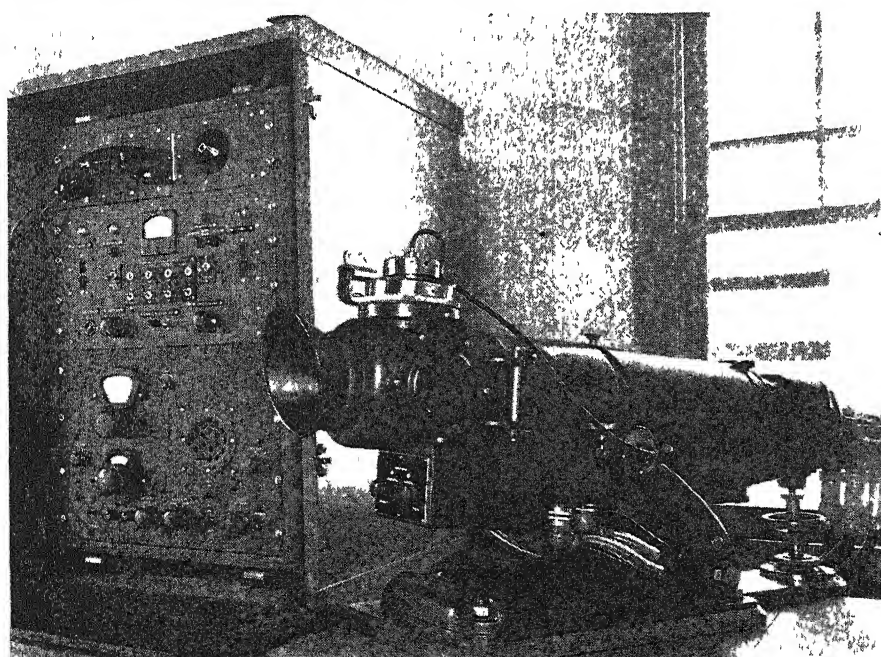
The new h-f d-f instrument, popularly known as "huff-duff," picks up any voice or code radio signal transmitted on international short-wave communications channels, and within a split second shows visually on the screen of a cathode-ray tube the

direction from which the signals are arriving. When such a bearing is obtained from two or more stations at different points ashore or afloat, a navigator can draw the lines of direction on a chart and read the position of the sending station at the intersection of the lines.

• LOOKING AHEAD •

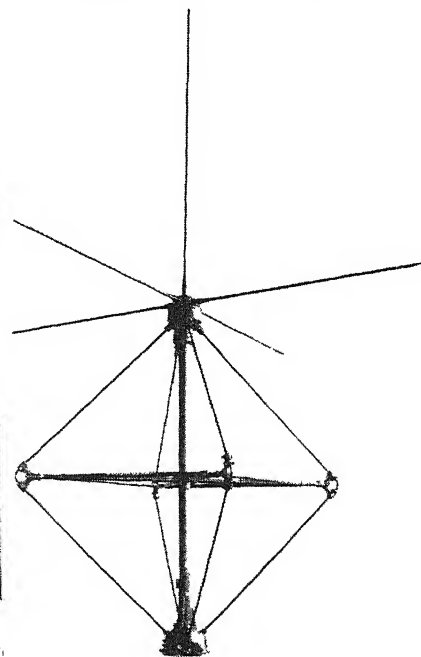
Transoceanic pilots will be able, by means of "huff-duff," to obtain exact positions at any time. . . Pin-point locations of planes or ships in distress can be obtained, and rescue parties dispatched. . . New radar beacons will make distance- and direction-finding simple and speed-up airport operations.

SUB SIGHTED—One spectacular use of "huff-duff" in getting a U-boat was made by Task Group 22.8, which on Christmas Day, 1944, was ordered to hunt down and destroy a weather-reporting German submarine operating about 500 miles north of the Azores. On January 1, 1945, the U-boat was picked up by radio direction finder bearing, at an estimated distance of 40 miles. No successful contact was made. The following day two ships got a fix (crossed bear-



Courtesy Federal Telecommunications Laboratories, Inc.

"Huff-Duff" station equipment—telescope-like unit houses cathode-ray screen; antenna is shown at right



ings) placing the submarine within 20 miles. Unfortunately, on January 9th the group was forced to depart for the Azores to refuel. On January 13th the hunt was resumed. Relying on d-f bearings, the U-boat was pursued south, north, and west as the bearings on his transmissions indicated changes of course. Persistence was rewarded on the morning of January 16th when the U-boat's radio transmission was intercepted by ships which fixed the enemy at six miles distant. The Task Group closed in for the kill. Two hours after the intercept, the sonar man picked up the U-boat. Exactly five hours after the intercept a violent underwater explosion indicated the end of another U-boat. Apparently this U-boat transmitted from a submerged position, because at six miles distance, radar had failed to locate it. The German use of the *Schnorchel*, the breathing device which permitted U-boats to run submerged and still charge their batteries and transmit radio signals, put a higher value than ever on radio direction finders, as bearings could be taken on transmissions made by submerged U-boats.

Another outstanding accomplishment of the equipment, Navy officers recently disclosed, was the locating of the German submarines which landed spies and saboteurs on the Long Island and Florida coasts in the spring of 1942.

SQUIRT TRANSMISSION — Enemy submarines used *Kurier* or squirt transmission—a system of radio communication in split-second bursts—to their bases in occupied territory, to one another in organizing their wolf-pack attacks, and in conveying weather information from this side of the Atlantic to the German high command. These compressed messages were picked up at the enemy receiving station on high-speed recording devices which later stretched the recorded message by playing it back at reduced speed.

It was believed by the enemy that the brevity of these radio contacts forestalled detection by any devices known to them. They were, of course, unaware of the new American direction finders on escort ships which revealed the location of the undersea craft the instant they started to transmit, no matter how briefly or, relatively, how far away. The new direction finder responds with precise accuracy to radio waves from across the Atlantic, or farther.

The location of an airplane crossing the ocean can now be determined immediately by "huff duff." Installations being provided on both sides

of the Atlantic will make available to a transoceanic pilot, who might be having navigational difficulty, a service which will give him his exact position at any time he requests it. Furthermore, these stations can immediately obtain a pin-point location of any plane in trouble and relay it to the nearest ships and shore rescue stations.

The high-frequency direction finder is now a vital instrument in the air-sea rescue system of the United States Coast Guard, which is organized through its bases along United States coast to dispatch immediately an airplane-rescue boat team to any scene of trouble at sea.

RADAR BEACON — Another wartime electronic development having commercial applications in the aviation industry is a radar beacon system that provides the pilot with a constant indication, on a cathode-ray tube screen, of his distance from, and his rate of approach to, the beacon. When a fix is desired, the plane sends out radar pulses toward

the nearest land radar beacon. The beacon responds automatically with an answering pulse carry an identifying code. The time it takes the pulses to make the round trip gives the plane's exact distance from the beacon.

Combining this data with a single direction bearing obtained with "huff-duff" or a similar high-frequency direction finder carried on the plane then gives to the pilot his exact position with relation to the beacon. Since beacon locations are known and are plotted on navigational charts, this information is entirely sufficient for a position fix.

Utilization of radar beacons on a nation-wide scale for all commercial planes and all airports would eliminate much of the bad-weather approach delays now encountered and would speed up landings, since the pilot would know his exact position with respect to the landing-strip radar beacon at all times. The Civil Aeronautics Authority is now investigating commercial utilization of this system.

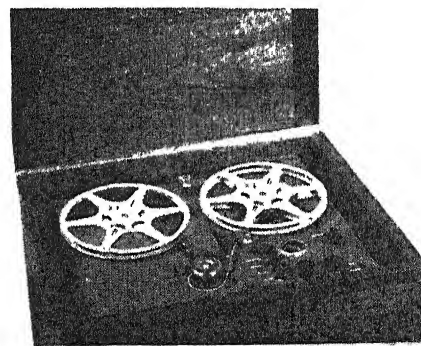
SOUND ON PAPER

*Made Possible by New
Magnetic Coating*

AFTER many false starts, magnetic recordings of voices, favorite radio programs, and messages for mailing to distant points are being made available on a new medium—a paper tape coated by a printing process with a thin film of magnetic material.

The development of the paper tape technique for home and office use is an outgrowth of forward strides made during the war in magnetic recording on a thin steel wire. The paper tape is about 0.003 inch thick and comes on a reel like that used on eight-millimeter home movie equipment. It passes from a supply reel to a take-up reel through a magnetic recording head. The latter is supplied with electrical energy by an electronic amplifier similar to those used on present-day home recording instruments. Variations of the sound-modulated electrical energy are transformed by the head into magnetic variations in the paper coating. The sounds to be recorded can be taken from a radio program or picked up by a microphone supplied with the instrument.

One of the advantages of the paper tape is that it can be cut at any point and a portion of the tape deleted. This permits the user to edit out unwanted portions of a radio program; for example, com-



Paper tape recorder and reproducer, with cabinet lid raised. The magnetic head is in center foreground.

mercial announcements. Splicing of the cut ends of tape is easily accomplished with an adhesive. Recordings can also be magnetically erased, in full or in part; this permits re-recording of new programs or sound, or adding material between wanted portions. The tape is expected to have a useful life in excess of that of the usual disk recordings. The first model of the paper-tape magnetic recording instrument, a product of The Brush Development Company, will be about the size of a table-top radio and is planned to be an accessory to the present home radio receiver. Each full reel of paper tape will accommodate a half hour of recorded material and can be rewound in less than a minute. Operation is quite simple and requires no more technical skill than that needed for

loading a movie camera. Business dictation machines are also contemplated.

Although magnetic recording offers many novel features, it cannot be expected that the conventional disk-type records will be replaced by reels of paper or wire. Disk records are pressed from a master in a matter of seconds in mass production. So far, no similar method of reproducing magnetically recorded reels is even on the horizon. Each reel of wire or coated paper tape would have to run through the recording head to receive the proper magnetizing effect; time alone is a considerable factor in this operation. For special programs, business records and dictation, and similar purposes, however, magnetic recording offers many advantages.

DULL-TOOL ALARM

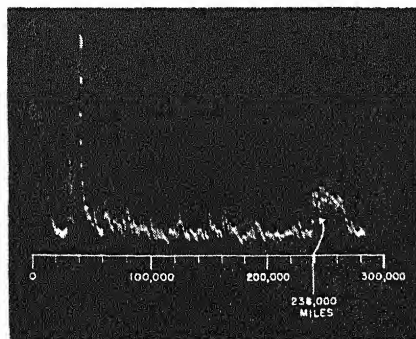
Prevents Overload and Breakage of Drills

AN ELECTRONIC control device, responding to increased torque load on the spindle of a drill, causes the drill to be withdrawn automatically when the cutting edges become dull. Torque loads exceeding a predetermined amount—usually between 1 and 10 percent above normal—start the automatic retractors, thus reducing drill breakage and speeding the drilling of deep holes. Where danger of breakage is negligible and automatic retraction unnecessary, the electronic control can simply be connected to operate a signal light. Ford Motor Company and H. E. Farmer Engineering Company are two of the firms that have already used this unique dull-tool alarm.

LUNAR RADAR

Presages Moon's Use as Radio Sounding Board

ON JANUARY 10, 1946, man made contact with the moon for the first time in the history of the world. Many authorities believe that this may point to radar controlled jet- or rocket-propelled missiles and space ships, circling the earth above the



Moon's reflection of radar signal is marked by jog in trace at 238,000 miles

stratosphere. But of more immediate significance is the possibility of improving radio reception over greater areas by reflecting radio signals off the moon rather than off the relatively low ionized layers in the upper atmosphere. Moon signals could be heard over the entire hemisphere of the earth that faces the moon, with essentially equal strength at all points. Success here depends on building a sufficiently high-power station and transmitting a sufficiently narrow beam so that the signal will be strong enough for radio reception after travelling its 480,000-mile round trip path. A number of laboratories throughout the world are now working on this commercial utilization of the moon.

COLLAPSIBLE TUBES

Can Now be Sealed Electronically

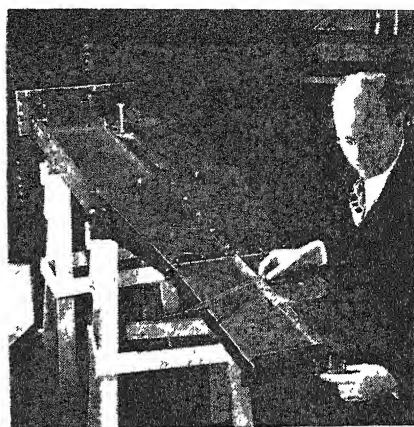
THE PROBLEM of having the ointment, tooth paste, or other contents of a collapsible metal tube squirt out at the wrong end due to opening of a folded and crimped seal, has been solved with the aid of electronic heating. The inner metal surfaces at the end of the tube are coated with a plastics bonding film, the end is folded as usual, and the fold is inserted in a single-turn coil connected to an electronic heating generator. The radio-frequency energy induced in the metal foil raises the temperature instantaneously to 250 degrees, Fahrenheit—enough to seal the tube securely. Heated crimping dies have hitherto proved unsatisfactory for the purpose because the soft lead would stick and the seal would pull open as the dies were retracted. With induction heating this is avoided because there is no physical contact between the metal and the source of heat. Up to 17,000 tubes per day are being sealed by this method, developed by Commonwealth Edison Company.

ELECTRONIC HEAT

Applied by High-Frequency "Blow-Torch" Technique

NEWEST in electronic heating is a unit that sprays radio-frequency energy onto the object to be heated, doing away with the older method of placing the object between two energized metal plates. The object, material, or liquid to be heated is simply placed in the opening of a rectangular metal pipe—technically known as a wave guide—that is energized by a high-power electronic generator. This blow-torch technique can be used effectively on irregular-shaped objects.

There is no danger of burning or



Electronic blow-torch in test stage. Later models will have smaller nozzles

scorching the material at points nearest the energy source. The higher the frequency, the smaller can be the opening in the pipe or nozzle, so that with sufficient power at a high frequency the beam of invisible heating energy can be squirted from a nozzle no larger in diameter than a flashlight.

SAND DRYING

Expedited by Phototube Control

TWO JOBS at the new Diesel locomotive maintenance shop of the Erie Railroad are done by phototubes.

The door of the shop is opened by the beam from the headlight of an approaching locomotive while it is still some distance away. This permits the locomotive to enter the shop without a preliminary stop. A sun visor over each phototube prevents the rays of the sun from activating it.

The sand for the sand boxes of the 5400-horsepower four-unit Diesel freight locomotives is dried by steam coils over a drum. A pipe in the side of this drum is so shaped that it permits sand to spill over when the drum is full. Through windows in the pipe a beam of light passes to a phototube.

When the drum fills with sand, the surplus flows into the pipe and interrupts the beam of light. Compressed air then closes the inlet to the drum and blows sand into elevated bins, where it is ready for use when required for servicing the locomotives.

When the drum is empty the windows are again clear and the light beam reaches the phototube. This turns off the compressed air, reopens the inlet to the drum, and allows it to fill again, ready for the next operation. This mechanism has proved more dependable than any previously used springs, switches, or other devices.

Premiums in Plastics

Advertising Specialties and Premiums are Big Business. Successful Use of these Mediums Means Meeting Unusual Requirements; Plastics are Often Naturals for the Job. Adaptable to Clever Designs, Permanent in Color, and Mass-Produicable, Plastics have a Real Edge in this Field

By CHARLES A. BRESKIN

Editor, *Modern Plastics*

BEFORE the war, premiums, prizes, and advertising specialties—in which category fell many plastics items—were big business. It is estimated that at manufacturers' prices their volume in 1941 exceeded 500 million dollars. And they are expected to pass the 600 million dollar mark as soon as goods are flowing freely again and competition once more sets in.

In the past, plastics products accounted for about 25 million dollars of this business, or 5 percent. Exactly what portion plastics will take of future business is still subject to question. However, authorities believe that plastics can reasonably hope to represent 10 to 15 percent of the total premium-prize-advertising specialties volume—a percentage that would be equivalent to 60 to 90 million dollars worth of business.

Before the suitability of plastics for this diversified field can be fully appreciated, a word of explanation on the premium and advertising specialty business seems necessary. Premiums are products offered in return for coupons, box tops, letters to advertisers, a trip to a store, services rendered, special purchases, or any of these plus a small amount of cash. A premium is an inducement to buy. It involves an effort as well as an outlay on the part of the customer.

Advertising specialties, on the other hand, are straight goodwill-promoting gifts, requiring no effort or outlay from the customer.

Some of the best known and largest volume plastics items have been premiums; for example, the Bab-O container of which over three million were turned out in urea-formaldehyde in a variety of colors. Started

● LOOKING AHEAD ●

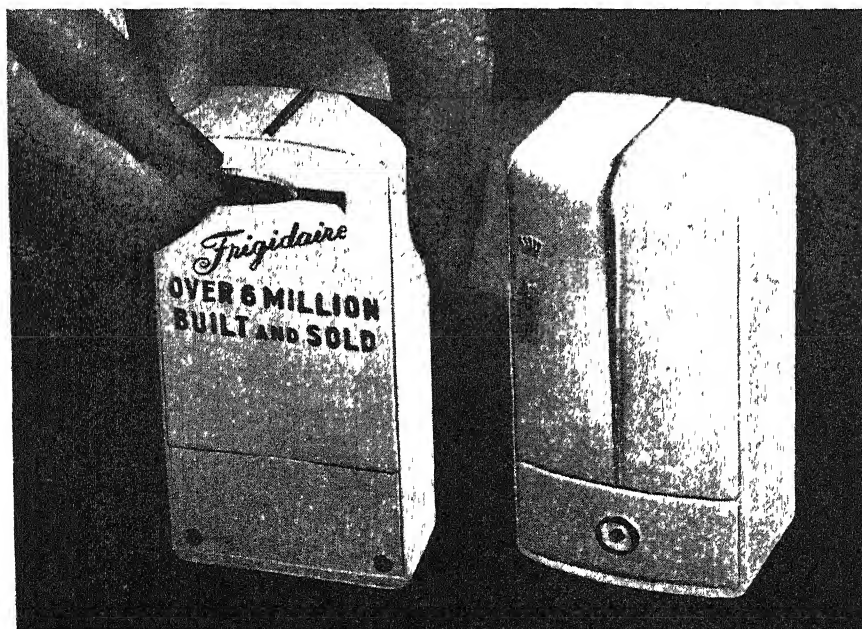
Business competition is coming back . . . So are the clever little advertising "give-aways" and inexpensive premiums. When designing them, production problems should be considered . . . Right now, sales-minded business men should be looking for premium ideas—and designers . . . Plastics offer possibilities as an outstanding material.

as a three-month promotion to expand sales, the holder proved so popular that the molding presses ran steadily for two years. Equally successful was the molded-urea Wheaties cereal bowl, and the Little Orphan Annie molded-urea mugs and shakers used to promote Ovaltine. Lone Ranger whistles, which were molded in three pieces of cellulose acetate, also reached a painfully popular level.

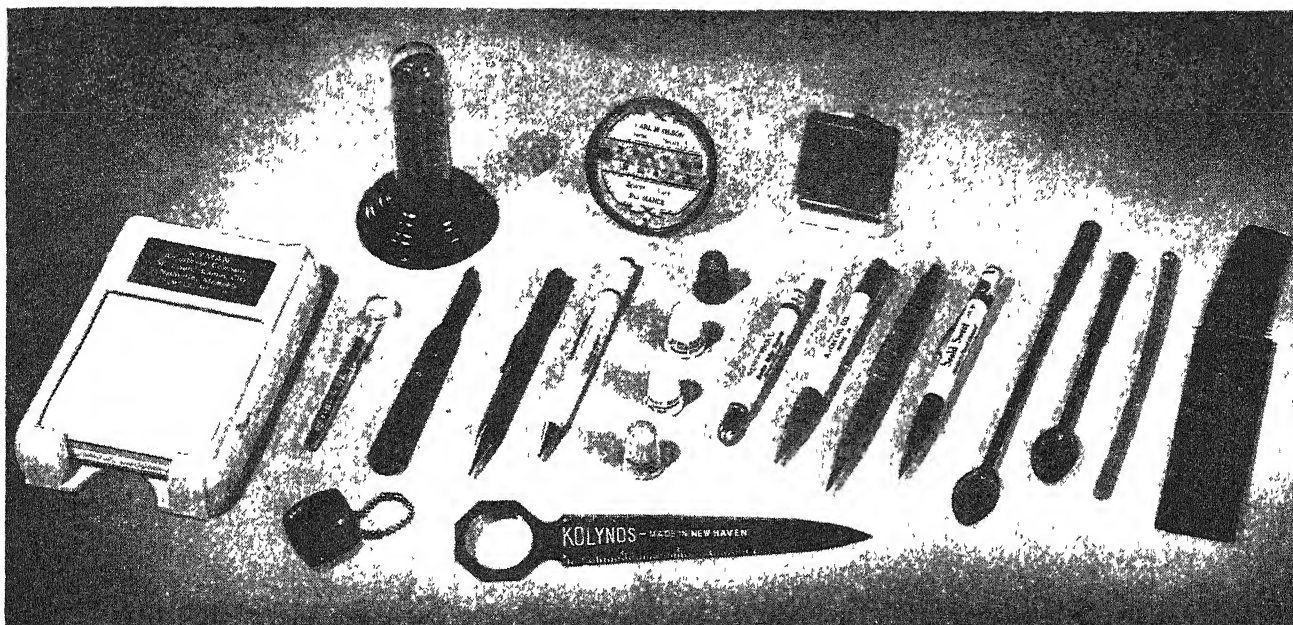
Why were these premiums so successful; and why were they made of plastics? Duane Jones advertising agency directs the distribution of over three million premiums a year. On the basis of their experience in the field they have set up a list of six desirable qualities for premiums, with comments on how plastics fit the picture.

REQUIREMENTS — 1. A clever idea is the basic element in all successful premiums. Standardized gadgets, no matter what the material, will never receive an enthusiastic response. If the idea is not new, it must possess other compensating advantages. Since these items are frequently "sold" to the public sight unseen, there must be a good talking point for advertising.

At first, the newness of plastics themselves gave them intrinsic



Popular cellulose acetate refrigerator bank was a durable, long-lived premium



Business names print well on plastics surface Color, an important attraction factor, does not wear off with use

cleverness. But, when the novelty wore off, plastics materials had other qualities which made them important to the achievement of something original. Because of their formability, plastics lend themselves exceedingly well to new design. Plus features are color and texture. Both the Lone Ranger whistle and the Bab-O container benefitted from these qualities of plastics. At the time these items went on the market, only plastics could give them inherent color—color that would not wear off—and do it at a low price and in mass production.

2. It is customary practice to try out an offer in a sales-resistant territory for a few weeks before making a national offer. Possibly 25,000 pieces are needed for the trial. If the results are good, orders varying between 400,000 and 1,000,000 may be placed. If the premium is that good—and many plastics premiums have been—additional orders for more millions may be placed.

Plastics are at a distinct advantage in meeting this premium testing sequence. Single-cavity molds can be made up for the test run; or a limited number of jigs may be used. This can be done without bringing the price up to a point where the part would be prohibitively expensive. In short, plastics are able to offer mass-production techniques on relatively small runs.

3. Premiums must have a universal appeal for housewives. Women are the big market for soaps, foods, dentifrices, and other things sold with premiums. An exception to this rule is the children's premium market. But even here it is preferable to offer something that will appeal to both boys and girls in a wide range of ages. And, again,

the color and formability of plastics are important. Moreover, formulations can be used that do not tarnish or stain, qualities of importance to women in their kitchen equipment. The variety of forms in which these materials are available is another element in helping them to meet these premium requirements.

4. A premium must be worthwhile and useful; the product leans on the premium, not the premium on the product. The numbers of plastics items that began their careers as premiums and are now standard retail merchandise prove the worth of these materials.

It would be hard to find a more useful, yet attractive piece than the Wheaties bowls. Being made of urea, they are less subject to breakage than china dishes; yet at the same time they are just as functional and colorful as bowls of any other material. Thus the use of plastics has added extra qualities while retaining all the traditional "musts" of tableware.

5 Exclusiveness is important. For real stimulus in a premium offer, the product should not be available anywhere else and, for at least six months after the offer is cancelled, should not be offered at retail at less than twice the "price" that people paid for it when it was a premium.

Proper management and an original designer are prerequisites to the fulfillment of this fifth premium qualification—points that can be worked out as well for plastics as for other materials. It is even possible that the formability of plastics gives them a slight edge here, since designers are less restricted than they are with many other materials.

6 A premium should, if possible, tie in with a fad or outstanding news event. The recent "Freedom-Sword Pin" premium, issued by Duane Jones, is an example. It was a miniature replica of the sword presented to General Eisenhower by the Lord Mayor of London, and it immediately caught women's fancies.

In meeting this sixth condition, fabricated plastics items have a distinct edge in that they can be put into production with a minimum of delay. To date most plastics premiums—and advertising specialties too—have been molded pieces. Fabricated parts should, however, play an increasingly important role due to the development of automatic machinery, improved techniques of fabricating, and the availability of new materials.

IDEAL MATERIALS—From the foregoing six premium qualifications, it would seem that plastics are ideal materials for this field, particularly in view of these materials' adaptability to mass production. Furthermore, they can be processed at a price which will not throw the advertising budget out of balance.

This low cost also has its dangers for plastics, and it is essential that premium buyers realize that. "Can we make it cheaper of plastics?" is no sound criterion on which to base a decision. The slogan should be: "Can we make it better of plastics?" If a premium is to be worthy of the product linked with it, it will cost more in any material than a mere expendable gimmick. A premium properly made of the right material need not be out of the question as far as cost goes. Post-war premiums have proved that, as did also a survey of premiums and



A plastics container for a household cleaner. Production topped 3,000,000

premium plans for 1940 conducted by *Printers' Ink Monthly*. In this last big year before the outbreak of war, the highest price to a customer for a premium was found to be 65 cents, plus a Rinso wrapper, for a three-quart saucepan. There were a few offers involving the sending of 50 cents in cash, many at 25 cents, a few at 15 cents. But most of the premiums went for 10 cents in cash.

While many of the qualities that are desirable in premiums are to be found in advertising specialties or "give aways," the emphasis is different. The cardinal features of a successful item in this category are light weight and a surface which takes a good imprint. The first is essential if costs of shipping and handling are to be kept down; the second in order that the name and address of the donor, and sometimes a sales message, can be permanently affixed to the item.

The big market is for office supplies, for premiums that can be used by business men, preferably at their desks, where purchasing decisions are made. But there is now a growing market for items with appeal to housewives, as well as an expanding children's market.

Advertising specialties must be clever enough in design to make an impression on the prospect. In most cases, this means that they must be designed especially for this field—not as an afterthought to the re-sale market. Ninety-five percent of the millions of dollars' worth of merchandise used in the advertising specialty field is manufactured solely for this purpose.

This field is wide open for new merchandise. Plastics molders are currently far behind orders on pre-war-designed items. The business is starving for goods and for clever ideas.

Thermoplastics hold the big interest in this field but many items made of urea and phenolic compounds and vinyl sheet are also

used. Prices to the jobbers range from two cents to two dollars a piece. Here is a list of advertising novelties found acceptable at all times:

Letter openers, thermometers, six-inch rulers, drink swizzlers, memo-pad holders, strong thimbles, desk calendars, pocket combs, desk magnifiers, key-chain gadgets, match-book cases, mechanical pencils, blotter covers, ash trays, long-drink spoons, and drink coasters.

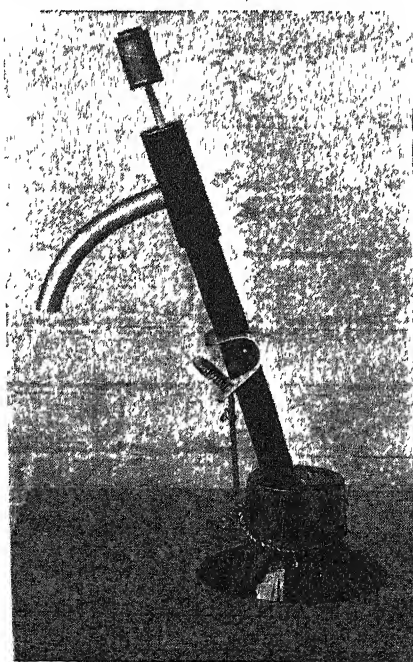
Lack of materials and mold making facilities are presently delaying the development of new plastics premiums and advertising specialties. But this is a temporary matter which should be ironed out by the time goods are in free enough supply to warrant once more the use of these sales aids. In the meantime, plans are being perfected so that, once the way is opened, plastics will be ready to help in the big push.



PLASTICS PUMP

Safely Handles Many Types of Solvents

THE ABILITY of certain plastics materials to withstand the effects of acids has been put to good account in a new suction pump produced by the Alden Speare's Sons Company. Except for two metal parts, the unit is entirely fabricated of Saran. The pump attaches to acid carboys and thus eliminates the juggling of carboys and the splashing of liquids. Bulk perfumes, flavoring extracts, syrups, and so on, can also be transferred with this pump, because of



Acids won't affect this pump

the materials' resistance to alcohols, oils, water, and acids.

CABLE STRAP

Holds Firmly, Allows Air Circulation

THE JOB of binding together multiple cable lines very often is a difficult one. If the holding strap is not tight, the cables can slip back and forth, quickly cutting the outer protective coverings. And the result is much the same if the binding is too tight. Now The Railroad Accessories Corporation offers a



Plastics-block cable strap

"beaded" strap as an answer to these troubles. This binding is an assembly of small compression-molded plastics blocks which are strung together on pliable wire. A special metal hook simplifies the union of the two ends. Using this strap, the cables can be pulled tightly together without danger of abrasion.

LETTERS AND MASKS

Made of Plastics To Aid Artists

ARTISTS and layout men will be aided by two new shortcuts based upon the success enjoyed by the cellulose acetate films used for military maps and documents during the war. Both developments, as announced by Arthur Brown and Brothers, consist of thin flexible Lumarith sheets coated on one side with a special pressure-sensitive adhesive and laminated, for protection, to thin opaque paper.

One product, the E-Z Frisket, is used to mask off the sections of a photograph that an artist does not want touched by the airbrush spray. The cellulose film is easily cut to the desired shape and is then peeled from the paper backing and placed over the art work. When the job is finished the film can readily be pulled from the copy, leaving no residue of adhesive.

Presto-Type, the second new use of Lumarith film, is printed with a quantity of black or white characters in any of 18 popular type styles. With this material a layout man can set his own type for headings in advertising and editorial layouts. The user cuts out the desired letters from the transparent film and places them in the final position on the copy where it remains because of the special adhesive on the back.

Rust Not — Want Not

• LOOKING AHEAD •

Costs of metals will increase as rich resources approach exhaustion. . . Rust prevention can conserve huge quantities of needed materials. . . Corrosion cause can be eliminated by use of inhibitors. . . Process is particularly adaptable to closed circulation systems. . . Metal life can be prolonged and operating efficiency improved. . . Other methods.

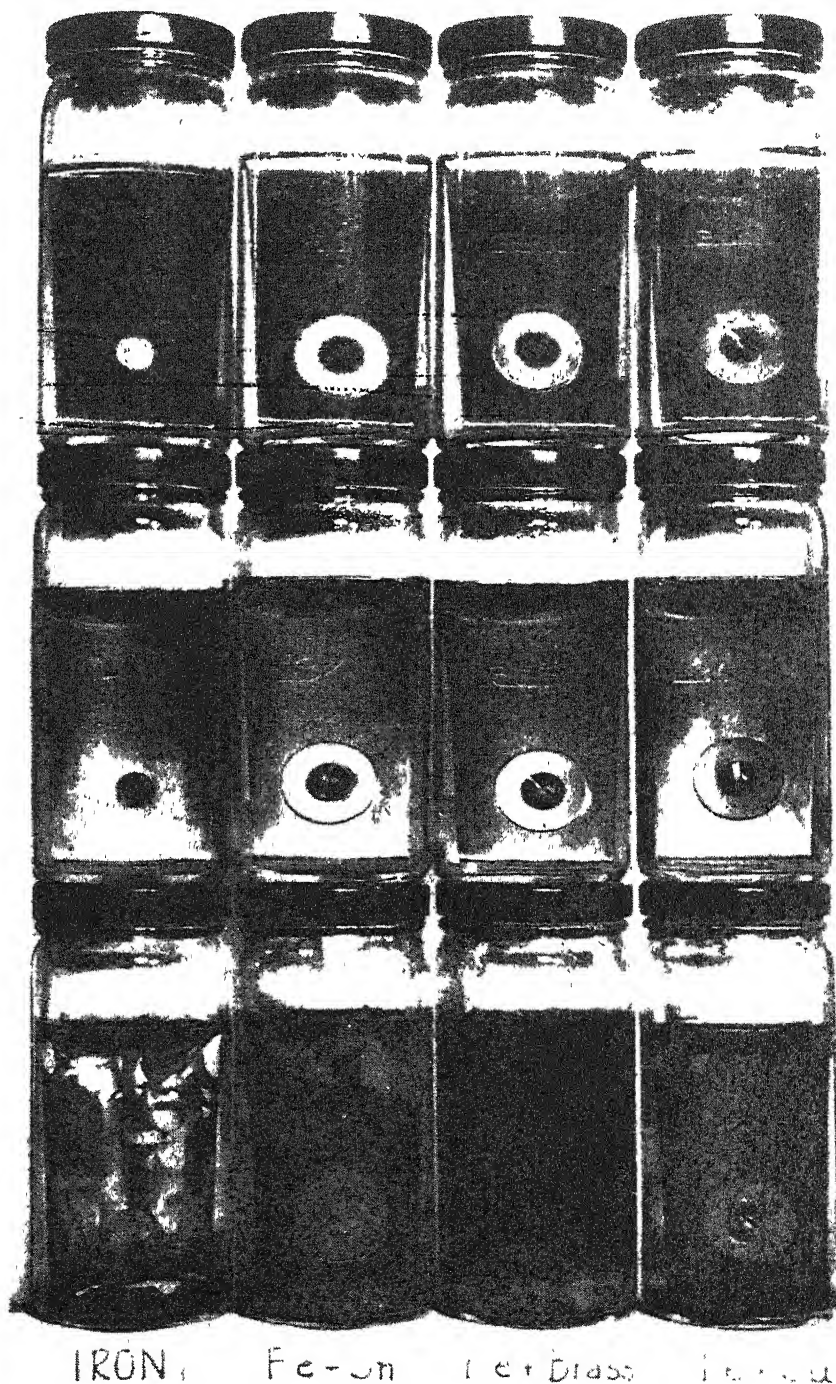
OUR BILL for rust and corrosion is almost equal to the value of our total metal production. The difference between the two represents new construction as compared with replacement. This huge bill for corrosion losses may not disturb you, because your part of it is so small; but if it doesn't yet, it will.

If the demands of war have proved anything, they have shown that our mineral resources are decidedly finite in extent and that already we are approaching limits. We still have plenty of most of the minerals that are important to us, but every indication points to eventual exhaustion of many and severe depletion of others. We shall be soon forced to perfect methods of using lower grade ores; they will yield higher priced metals. Thus, whether we realize it or not, the problems of suppressing rust and corrosion press for solution now and must be solved to relieve the mounting strain on our mineral deposits.

Several important advances in corrosion prevention have been forced by war. Not the least important of these is the wider recognition and use of inhibitors—substances which, added to water in extremely small concentrations, profoundly affect its corrosion char-

Of the Various Methods of Protection Against the Ravages of Corrosion, Inhibitive Treatment Offers Simplicity and Wide Applicability. Corrosion Control Now More Necessary Than Ever as Metals Supplies Dwindle

By D. H. KILLEFFER
Chemical Engineer



Right: Corrosion tests using tap water, and tap water plus inhibitors, to determine effects on iron and combinations of iron and other metals as labeled. Photograph was taken after six months at room temperature. Bottom row of containers hold plain tap water. To containers in second row had been added sodium chromate; to ones in top row, sodium bichromate

acteristics. While agents of this type have long been known, and used, the present situation and the immediate prospect lend particular importance to them.

Most important in the class of inhibitors are silicates, chromates, and phosphates. When any of these is added to water in tiny concentration, it exerts a powerful influence on what happens to metals immersed in the water. Corrosion is prevented, stopped, or materially reduced. Fortunately enough, these agents protect, to useful but variable degrees, all of the common metals ordinarily subject to more or less severe corrosion. That fact became especially important during the war years when other protective means—alloying, plating, and painting—were restricted by lack of required materials. Furthermore, the simplicity and wide applicability of inhibitive treatment make it particularly interesting and valuable.

ELECTROLYTIC ACTION — Basic among causes of corrosion are electrolytic differences between parts of a system made up of metal and water. The metal itself may have areas exposed to the water which differ from each other in composition or in previous treatment. Tiny and otherwise negligible variations may be great enough to set up minute differences of electrolytic potential between them when immersed in water. This may easily happen even on a single piece of sheet metal. If no variation occurs in its composition, so slight a cause as a blow by a hammer or a bend or other deformation may be sufficient to set up a corrosion-promoting potential difference. Because the tiny forces involved continue to act over long periods of time—years and not just minutes—the forces themselves and the effects produced per unit of time need not be great to work grave havoc ultimately. If two quite dissimilar metals such as iron and copper are in contact, the effect may be greatly magnified.

A second and only slightly less important cause of corrosion lies in the creation of electrolytic potential by differences of concentration of substances dissolved in the water. Oxygen, for instance, is only sparingly soluble in water, but becomes so concentrated at the surface of water as to set up severe corrosion at this point on a piece of steel partly immersed. This pronounced effect occurs in milder form wherever an opportunity exists for variations in concentration of dissolved substances to come in contact with submerged metal.

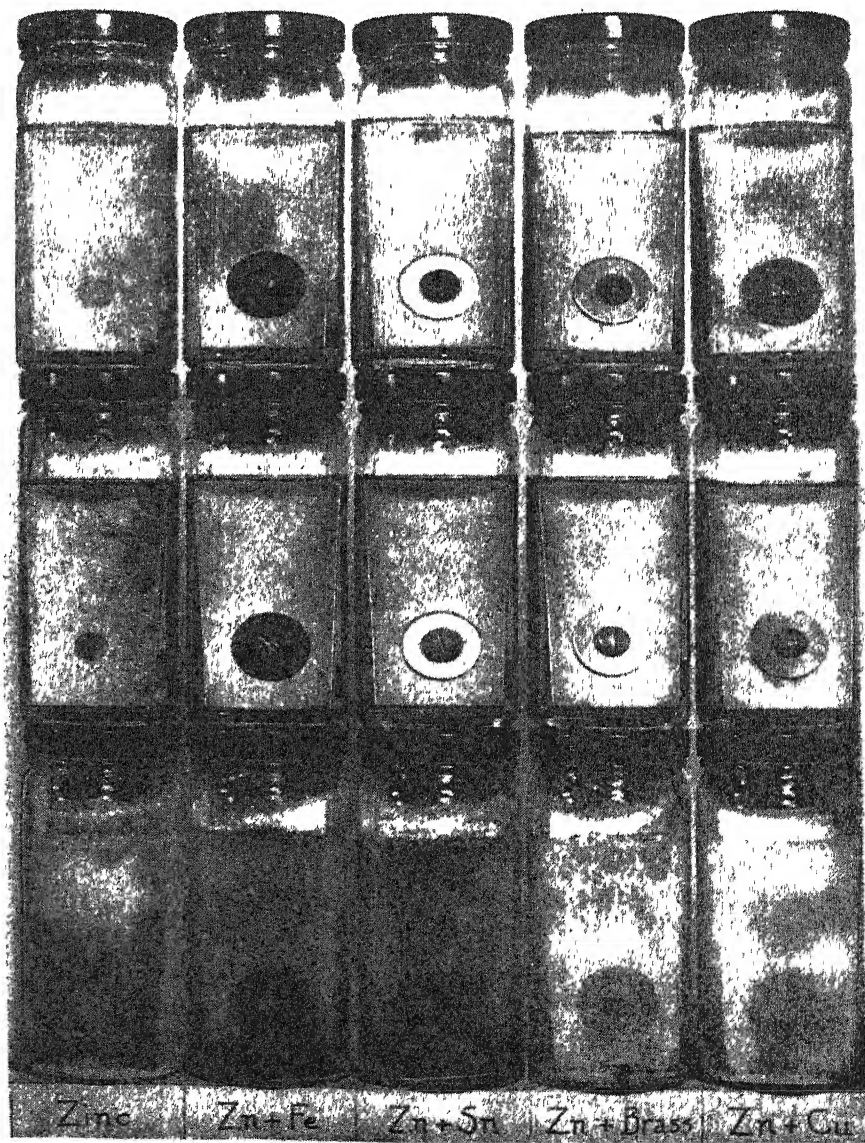
The effect in either of these cases

is to create what amounts to an electric battery. This results in dissolving metal anodic areas and thereby causing corrosion and ultimate failure of the metal part. Experts in corrosion carry this explanation considerably farther, but it suffices to look upon corrosion of submerged or wetted metal as occurring in a miniature of an electric battery where the two plates may actually be different parts of the same metal surface

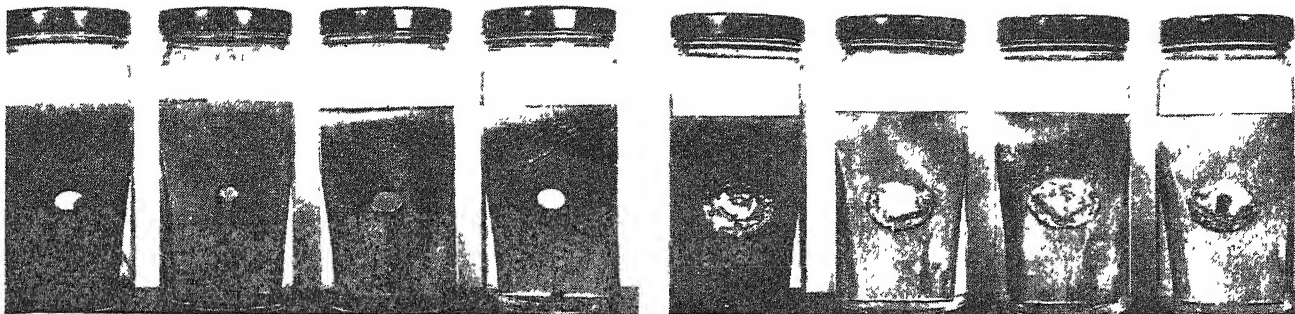
KEEP WATER AWAY — Obviously the most satisfactory way to protect metal under such circumstances is to prevent its contact with the water—the electrolyte. Plating and painting are the obvious methods of applying such protection but neither can be universally employed. It is impractical, for instance, to plate or paint the surfaces of the water channels in the castings of internal combustion engines or in the restricted water passages in radiators of auto-

mobiles. Alloying, too, for the purpose of minimizing potential differences is ordinarily impractical in these items. However, the cooling water of such systems is used over and over by recirculation. That is ideal for inhibitive protection and the addition of tiny amounts of inhibiting substances practically prevents corrosion in the system in spite of the fact that several metals—iron, brass, solder, and so on—are usually present

Numerous substances have been successfully employed as inhibitors—so many, in fact, that mere naming of them would unduly lengthen and complicate this discussion. Many organic substances—tannin, numerous amino compounds, and certain of the phenols among them—possess inhibitive properties. Several classes of inorganic compounds, notably chromates, silicates, and certain of the phosphates, are similarly effective and are generally applicable in concentrations so small



Corrosion tests on zinc and combinations of zinc with other metals. Conditions and inhibitors used are the same as in the tests on iron, shown on page 161



Above Corrosion tests on iron panels submerged in (from left to right) tap water and, respectively, 62.5, 125, and 250 parts per million of sodium chromate. The test jars in the illustration at the right show cathodic protection of iron panels in contact with zinc anodes. Inhibitor used was the same, and in the same

Mutual Chemical Company of America

respective concentrations, as in the illustration at the left. Note that cathodic protection due to the zinc was insufficient to prevent corrosion of the first panel but that 62.5 parts per million of chromate produced almost perfect inhibition. Tests were conducted at room temperature over a period of two years.

that any other effect they might have is quite negligible.

These corrosion-inhibiting substances apparently act by forming protective coatings which consist of compounds produced from initially dissolved traces of the metal. For example, a piece of clean iron or steel immersed in a dilute, neutral solution of sodium chromate (25 to 250 parts per million) is quickly covered by an extremely thin film of what may be considered an iron chromate. This film seems to be continuous and self healing in solutions of chromate. It is also insulative even in extremely thin layers and effectively prevents the flow of electric current, essential to corrosion, to and through the solution.

The mechanism of the protective action seems reasonably clear: formation of an insulating and protecting layer over the endangered area by precipitation on it of an insoluble compound of the metal itself. Such an explanation serves admirably for ferrous metals protected by chromates, silicates, and glassy meta-phosphates. The needed concentrations of any of these are so small as to be negligible for most industrial purposes, being conveniently expressed in parts per million rather than as percentages.

CLOSED SYSTEMS—The type of corrosion which lends itself best to inhibitive protection is that encountered in stationary or recirculated water systems. Examples are: cooling systems for internal combustion engines; refrigerating brine systems; hot-water heating systems; air washers of air conditioning systems; boilers of heating systems; and similar installations. In any of these the life of the metal involved can be prolonged many fold and the operating efficiency of the system greatly improved by avoiding the formation of rust and other corrosion products on heat transfer surfaces.

The protection imparted by inhibitors has also been provided by so handling the composition of the water as to create a thin, controlled film of calcium carbonate scale over the ferrous metal surface. Under careful control a crystalline, insulating film of this scale-forming compound can be maintained in piping systems, for instance, to suppress corrosion effectively.

The increasing use of the light metals, aluminum and magnesium, emphasizes greater need than ever before for such protective measures wherever these metals are immersed in water or aqueous solutions. Aluminum readily forms protective anodic coatings of aluminum oxide, as do some of the alloys of magnesium and the pure metal itself when properly treated. Both possess, however, properties quite different from those of iron and the more familiar structural metals and require suitable modification of methods of treatment.

Magnesium is so easily corroded in the pure state that it has found important use in the "sacrificial" protection of pipelines buried in moist corrosive soil. For this purpose, pigs of pure magnesium are buried close to oil pipelines and connected to them by heavy electric conductors. Under these circumstances, the magnesium becomes the anode of an electrolytic system in which the iron of the pipeline is protected as the cathode. Varying the composition of the magnesium ingots permits selection of the most efficient alloy to give adequate protection with minimum consumption of metal.

ONE OF MANY—This by no means exhausts the subject of corrosion prevention. It simply points out the importance of one phase of the attack on a universal problem. The return of alloying and plating elements, now demobilized; improvements in protective coatings, both

temporary and permanent; and new techniques involving dehydrating the air around metal objects in storage are all contributing importantly to reducing corrosion and its drain on our metal resources. But all effective efforts in this direction are useful. Before it is too late, all industry must adopt the slogan: "Rust not—want not."

• • •

ARSENIC HAZARDS

Reduced by War-Gas Antidote

BBRITISH scientists are reported to have developed a compound effective against Lewisite, most dreaded of all the war gases. Fortunately unneeded during the war, this compound, 2,3-dimercaptopropanol, called BAL,—British Anti-Lewisite—is expected to be valuable in the treatment of civilian arsenical poisoning occasionally encountered among trades employing arsenic compounds.

NEW ELEMENTS

Possess Atomic Numbers 95 and 96

AATOMIC fission and atomic bombs have resulted, among other things, in the discovery of four new elements having atomic weights and atomic numbers greater than those of uranium, long considered the probable end of the chemists' periodic system of elements. Neptunium and plutonium played important parts in the atomic energy operation. Two other elements have now been discovered which follow neptunium and plutonium in the expected sequence. They have not yet been named. The latest discoveries possess atomic numbers 95 and 96, following uranium as 92, neptunium, 93, and plutonium, 94.

Research For Power

Aircraft Engines, Turbines, and Jets do not "Just Grow" Painstaking Research must Precede even Minor Advances, and Tomorrow's Supersonic Speeds Require Experimental Laboratories Undreamed of Yesterday The NACA Engine Laboratory at Cleveland Meets these Needs

By ALEXANDER KLEMIN

Aeronautical Consultant; Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

FLIGHT at sonic or supersonic speeds points with new emphasis to the need for laboratories for fundamental aeronautical research. Paper and pencil and slide-rules, coupled with actual flight test can, respectively, pave the way for, and prove, technical advances. But fundamental research calls for high-speed wind tunnels; for wind tunnels that can simulate the conditions present at extreme altitudes; and for extensive precision equipment.

Outstanding among the aircraft engine research facilities of this type is the new Cleveland Aircraft Engine Laboratory operated by the National Advisory Committee for Aeronautics, of which Dr. G. W. Lewis is the able director. Whereas other NACA laboratories are largely specialized in aerodynamic research, the \$24,000,000 Cleveland Laboratory devotes 15 large buildings—the Engine Research Building alone comprises five and one half acres of floor space—to all the elements of the power plant; the engine itself and its many accessories.

The Altitude Wind Tunnel, of particular interest even in this wealth of equipment, is probably the only one of its kind in the world. Here, expensive, difficult, and sometimes inaccurate flight testing is supplanted by operation of complete aircraft propulsion installations under precise temperature, humidity, and pressure conditions such as would be found at 30,000 feet. Moreover, pressure conditions up to 50,000 feet can be simulated, and when the full 50,000 horsepower available to the tunnel is employed, air speeds as high as 500 miles per hour may be obtained. Temperature controls for the tunnel require the world's largest refrigeration plant with a capacity equivalent to 20,000,000 pounds of ice daily.

TURBINE RESEARCH—But interesting as the tunnel is in itself, the projects tested in it are of even greater interest. Considerable work is being done on gas turbines and "compound engines" of various types. Gas turbine driven propellers

• LOOKING AHEAD •

Economical 500-mile-per-hour transports a possibility within the next five years. . . Gas turbine plus conventional engine combination points way toward increased payload. . . Athodyd engines offer possibilities of supersonic plane speeds. . . Icing of plane parts still being studied.

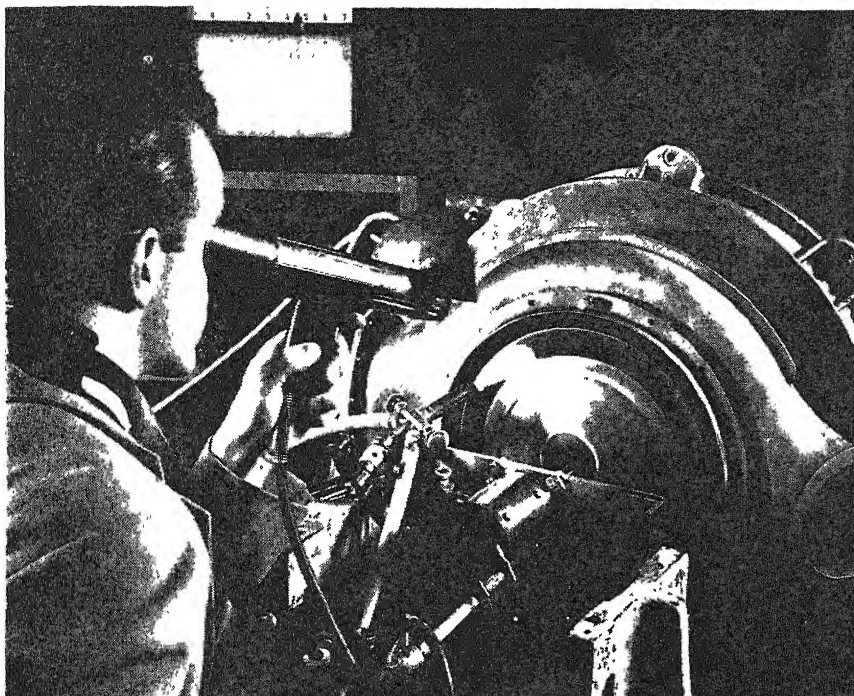
—described by some authorities as making economical 500-mile-per-hour transports a possibility within the next five years—are being tested and compared with "compound engines." The latter term is applied to a reciprocating engine combined with an exhaust-driven gas turbine which is geared to the engine crankshaft. Further reports describe "blow-down" turbines that incorporate siamese exhaust stack arrangements through which gases are fed to separate turbine nozzles from each engine cylinder.

The following results are an excellent illustration of the valuable data obtainable through experiments in the altitude wind-tunnel. The engine used in each of the three combinations was a conventional Pratt and Whitney reciprocating design of the radial type and with 2800 cubic inches piston displacement. The three combinations tested were: the engine with a standard turbo-supercharger; the engine with a steady-flow exhaust-gas turbine geared to the crankshaft; and the engine with a "blow-down" turbine and steady-flow turbine in series. Fuel consumptions for the three combinations were: .41, .34, and .30 pounds per brake horsepower hour respectively. While the importance of these fuel consumption differentials may not be apparent when

viewed alone, they loom surprisingly large when viewed in terms of payload. If, for example, the .11 pounds per brake horsepower hour differential between the turbo-supercharger and the "blow-down" plus steady flow turbine combination could be maintained under flight conditions, the slight margin of fuel saved would amount to approximately 25 more passengers or 5000 pounds of cargo on a 10 hour flight. This is based on a four-engine plane and an estimated passenger-plus-baggage weight of 200 pounds.

Another important altitude tunnel project is concerned with increasing the thrust of turbo-jet engines during take-off and climb. The low thrust, characteristic of jets under slow-speed conditions, has been augmented in wind-tunnel tests in three ways: water-alcohol injection in combination with an adjustable tail-pipe nozzle; combustion in the tail pipe; and an auxiliary combustion chamber and nozzle plus water-alcohol injection. Flight tests have confirmed wind-tunnel findings of increased thrust and shortened take-off runs.

Gas-turbine and turbo-jet investigations at the Cleveland laboratory are not, however, confined to overall measurements of thrust and propulsive efficiency. The most minute operating parts in turbine engines must function unfailingly, usually under conditions of extreme heat, pressure, and speed. Typical of the research efforts concerned with elements rather than entire units, are the programs aimed at improving the design of turbine blades and compressor impellers. Maximum turbine efficiency, from the thermodynamic standpoint, requires high initial temperatures for



the incoming gases. But this desirable factor must be weighed against the ability of the metal turbine wheels to withstand the high gas velocities, temperatures, and rotational speeds involved. Ordinary metals would be short-lived in such an application. Present metals stand up amazingly well when the severity of the service is considered. But the road to the ultimate in turbine efficiency and blade life is now being scouted at Cleveland with laboratory equipment designed to simulate actual operating conditions. By rotating the wheels under intense heat and pressure, while engineers make close observation of the temperatures and other variables, design features effecting power output and blade life may be accurately evaluated and analyzed.

Similar testing is carried out on the impeller unit of the compressor—needed to compress the fuel-air mixture before burning—to insure that the impellers have the required strength at high rotational speeds. Frequently the impellers are tested to the point of destruction by rotating them so fast that they burst apart.

ATHODYDS—Turning from problems involving reciprocating engines and turbines to the pure ram-jet or athodyd engine, entirely new methods of research become necessary. Although it appears that this type of engine alone can bring planes into the supersonic speed range, singular research difficulties are encountered. These difficulties hinge on the vast amounts of outside air required for athodyd combustion and the extreme speeds at which

If test results are to be accurate, aviation research must simulate actual flight conditions.

Above: Testing gas turbine blades with heat,
Right: Measuring ice build-up on test antenna in icing tunnel



this air must be handled. Under such circumstances, the air-flow patterns differ considerably from those obtained at normal speeds. Consequently, it was necessary to construct a "supersonic-propulsion-research" wind tunnel. An integral part of the altitude tunnel, the supersonic tunnel uses the former's air conditioning equipment and exhaust system but provides wind velocities equivalent to 2000 miles per hour, or well into the supersonic range. The supersonic tunnel has a cross section of only two and one quarter square feet—explaining in part the high velocities obtained—and provides a means of mounting the model so that all aerodynamic forces as well as thrust may be measured.

The athodyd tested at Cleveland consists of a long tube with interior passages carefully shaped to take maximum advantage of the ram action of the fuel-air inlets, and an electrical source of heat to ignite the fuel. At low Mach numbers—the ratio of the air speed to the speed of sound—the athodyd's fuel consumption is prohibitively high. But when the Mach number is two—the speed of the air twice the speed of

sound—the fuel consumption is only 8 pounds per thrust horsepower hour. This alone makes the athodyd highly promising for the so-called "super-aviation" of the future.

Visualization of the air flow as well as measurement of the forces involved, is extremely helpful in studying these high-speed power plants. For this purpose, a "Schlieren" camera—old in principle but new in application—is used. The Schlieren camera depends on the change in the air's index of optical refraction that accompanies a change in air density. This principle, aided by strong electrical sparks, provides photographs which show regions of varying air density and enable the skilled interpreter to determine

regions of compressibility shock. Further investigations are then carried out to find means of avoiding these shocks by appropriate aerodynamic changes.

FLIGHT TEST—Ultimately, power plant installations must be tested in flight, and the first flight always involves certain critical factors. In particular, it is most important that the engine be adequately cooled. Accordingly, the Cleveland Laboratory has devised a portable blower capable of producing a 250 mile-per-hour blast for test cooling prior to take-off. This portable blower helps reduce any element of doubt that might exist as to engine cooling.

Modern aircraft research equipment is too complex for flight observation by one or two men, no matter how skilled and efficient. Personal observers are replaced as much as possible by automatic recording devices and on a single flight of a B-24 bomber with experimental equipment, 10,000 readings can be obtained and recorded. Nevertheless, well protected research workers, complete with heated suit and oxygen mask, are still needed to observe and operate

the many instruments and recording devices connected to various parts of the airplane or power plant.

The trend of modern airplane operation indicates future all-weather operation, immune to wind, fog, and ice. Wind no longer stops an airplane, and its effects will be less and less as cruising speeds go up. Fog will be met, it is now hoped, by radar and other blind flying devices. But ice formation, in spite of de-icer boots and exhaust-gas heating of the leading edge of the airfoils, still constitutes a problem. The NACA is therefore continuing and expanding its investigations of icing with such equipment as the Ice Research Tunnel. This tunnel consists of three sections: the first six feet by nine feet for studying engines, cowls, and wings; a larger 12 by 15 foot section for work on propellers; and the largest, 26 by 29½ feet for tests on helicopter rotors. So far there has been no reported instance of helicopter rotors icing up, but the possibility must exist. Temperatures in the icing tunnel can be reduced to minus 60 degrees, Fahrenheit, and the air speed can be raised to 400 miles per hour. Accurate controls of temperatures, spray drop sizes, and air speeds to simulate any flight conditions are obtainable. Measurement of the thickness of ice deposited in a given period of time is an important element of research and one that varies greatly with meteorological and operational factors.

Another project of considerable practical importance is directed towards a reduction of fuel vapor loss. When gasoline in airplane tanks or drums is subjected to the heat of the sun at ground level, and is then carried up to altitudes of 15,000 feet or more, the fuel literally boils away, and the range of aircraft may be greatly reduced. It is reported that on one experimental flight of a B-29, vaporization loss started at 15,000 feet, amounted to 450 gallons out of 8000 gallons at 25,000 feet, and 900 gallons at 35,000 feet—equivalent to a payload loss of 2¼ tons. There is a further loss due to foaming, which increases with rate of climb. In the NACA investigation of boiling and foaming problems, three remedies are under consideration. One is the use of intercoolers similar to those used in superchargers; another is pre-cooling of the fuel on the ground; and the other is pressurization of the fuel so that the boiling away process is checked.

Although the NACA Engine Laboratory does not actually design and build engines, it is charged with providing designers and con-

structors with fundamental information of the highest value. During the war, Langley Field, Moffett Field, and Cleveland necessarily concentrated their efforts on aiding the Army and Navy, or helping the airplane and engine contractors working for the Army and Navy. Now, part of the research of the NACA will undoubtedly be focused on peace-time aviation.



BELL JAR

Provides Made-to-Order "Altitude" for Aircraft Ignition Research

FOR TESTING aircraft engine ignition under altitude conditions, a new bell jar has been developed by Wright Aeronautical Corporation. Two troubles are common to aircraft ignition systems: corona, a faint violet light indicating electrical leakage around ignition system parts which are under high electrical stress; and flashover, due to moisture, which permits energy to go to "ground" instead of to the spark plug. Both troubles are more likely to occur in the thin air and low temperatures of high altitude. The bell jar, providing varying atmospheric conditions and sealed by its own weight on a rubber gasket at its base, consists of a 350-pound Plexiglas dome, built by Rohm and Haas from basic Wright designs.

The ignition harness is mounted within the dome in the same position as in actual operation. Spark plugs are set into spark plug bombs, with the bombs set up on a spoke-like arrangement of nine arms

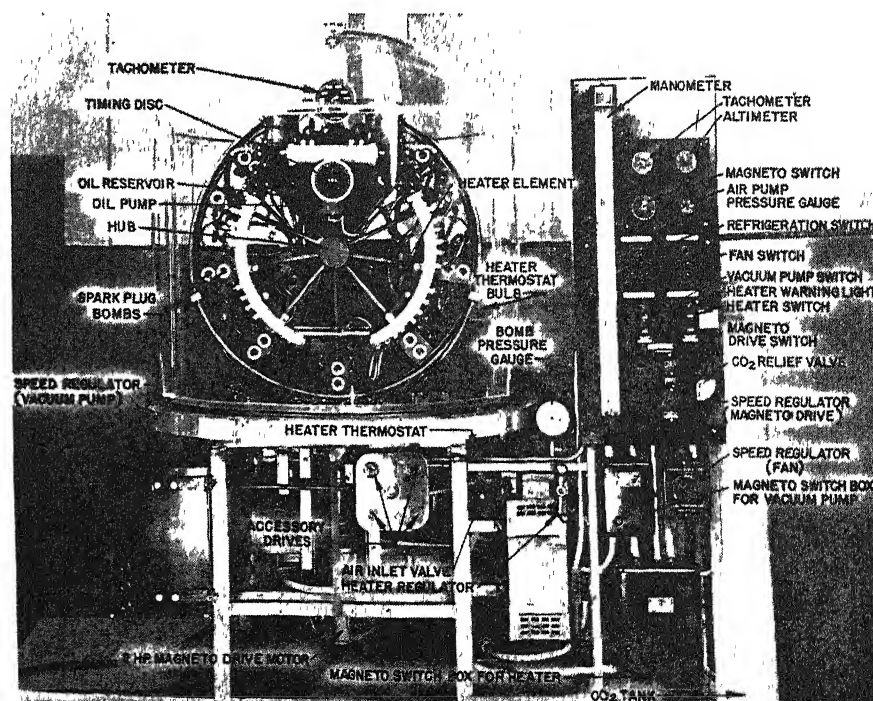
stemming from a central hub. Each bomb carries four plugs and has a window for observation purposes.

To simulate the hot gases and fuel mixture of an actual engine, carbon dioxide under pressure, is supplied to each of the bombs. An electrical motor drives the magneto and distributors and progress of the ignition cycle can be checked by a timing disk. Pressure inside the bell jar is reduced very quickly by an aircraft vacuum pump to the equivalent of a 65,000-foot altitude, while a special refrigerating system and an electric heater give rapid and powerful temperature control. The bell jar has proved invaluable in ignition research, and enables data to be obtained in a few hours in the laboratory which could otherwise be obtained only by hours of expensive test flights.

HELICOPTER RECORDS

Prove Design Progress as Well as Aircraft's Abilities

NEW HELICOPTER records were recently established when a Sikorsky R-5, flown light, reached an altitude of 21,000 feet. With 16 people seated on benches secured to the landing gear, and one extra passenger inside the cabin—a total load of about 27,000 pounds—the rotary-winged craft hovered 10 or 15 feet off the ground. Top speed—light—with a 450-horsepower Wasp engine and an estimated gross weight of over 4000 pounds, was recorded as 114.6 miles per hour. This compares with a 76 miles per hour record speed set by a Focke helicopter only seven years ago.



Simulation of many high-altitude ignition variables requires complex controls

'Alloyed' Oils

No Longer Dependent on any Particular Crudes for Top Quality Engine Oils, Lubricant Manufacturers Can Now Refine Severely, then Build Oils to Specific Jobs. Chemical Additives are the Answer

By A BRUCE BOEHM

Assistant Manager, Paraffin Sales Division, Stanco Distributors Incorporated (Subsidiary, Standard Oil Company, New Jersey)

HIGHER speeds, higher loads, higher pressures, higher temperatures, leaner fuel-air ratios, and thermally-cracked fuels all tend to cause oil deterioration in modern engines. These increasingly severe conditions occur in both Diesel and gasoline engines. And they call for new oils—oils that are resistant to deterioration in the crankcase—and

● LOOKING AHEAD ●

Lubricating oils for gasoline and Diesel engines can now be "tailor-made" for specific purposes. . . New lubricants can keep engines clean, prevent formation of gum and varnish, and be made with controlled viscosity. . . All of which points toward greater economy for commercial fleet operators—and even for the individual motorist. . . Less wear on engine parts and reduced corrosion will mean reduced maintenance costs.

and other parts of the engine. Alloy bearings have suffered from corrosion brought about by severely oxidized oil. Sludge deposits have formed in the valve chambers, crankcase, and elsewhere to give harmful, dirty, engine conditions. All this meant expense to the engine operator—expense for maintenance, repair, and for idle equipment.

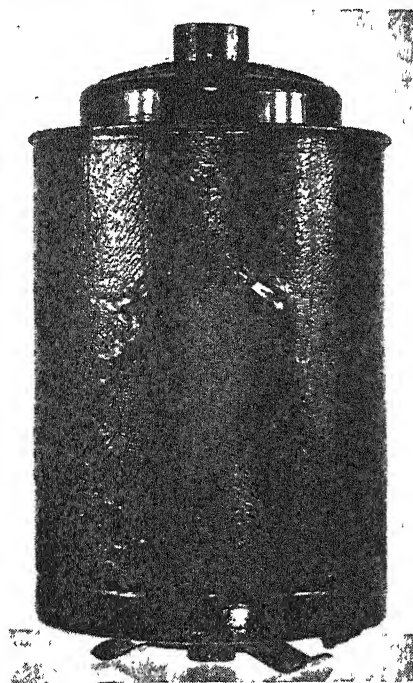
Not all users of motor oil, of course, had these worries. Fortunately, such troubles have generally been confined to engines in heavy duty service. But as engine development continues, more and more equipment is coming within this rather broad "heavy duty" classification.

Petroleum refiners, aware of the new demands thus brought about, have directed a tremendous amount of research towards the development of oils that will solve the most severe lubrication problems. Such oils, to meet the service requirements, must be able to improve engine cleanliness substantially, provide really trouble-free lubrication of pistons and rings, and minimize any excessive wear that may be experienced under heavy-duty conditions. Moreover, these oils must

be non-corrosive with respect to bearing alloys, and must remain so under the most severe use.

Just as the steel industry turns to alloy steels for tough jobs, so has the petroleum industry turned to what might be thought of as "alloyed" oils.

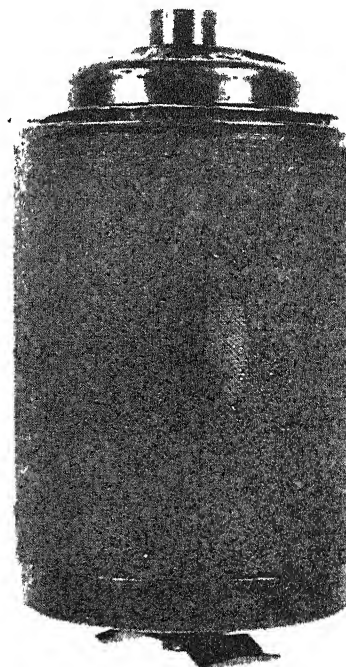
ADDITIVES—To make heavy-duty oils, special substances are added to well-refined petroleum oils. These substances, often complex chemical compounds, and generally used in relatively small proportions, are known as "additives." Additives have been defined as chemical compounds not normally present in a refined oil, which give certain properties not possessed by the oil, or



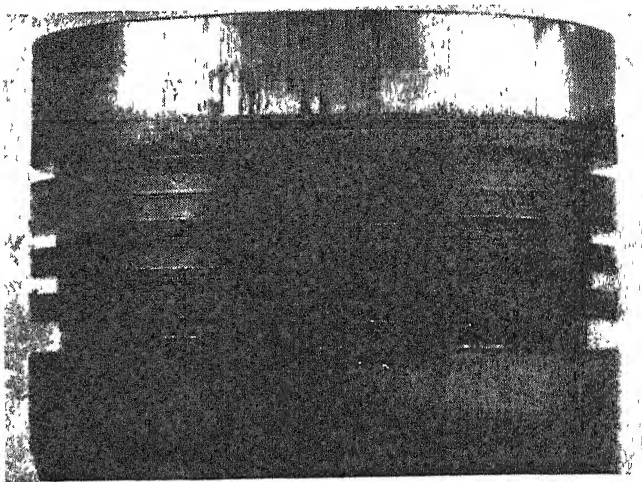
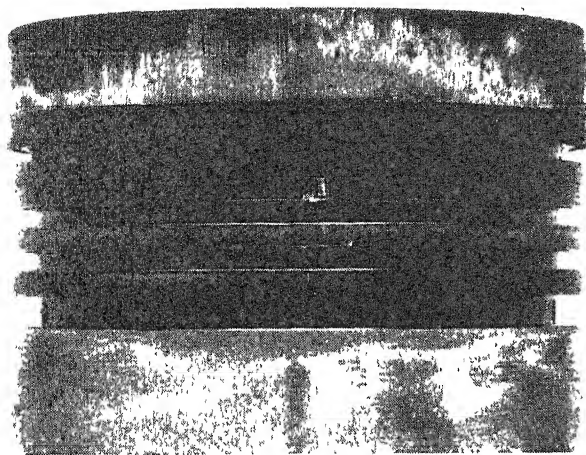
Oil filter after 300 hours operation on good motor oil without detergent

that lubricate without breaking down on the flame-bathed pistons, cylinders, and valves.

Stuck piston rings have been the nightmare of operators of high-speed Diesel and heavy-duty gasoline engines. Even the best oils have, at times, been unable to prevent deposits in the ring zone and formation of "varnish" on the piston skirts



Remarkably clean, this oil filter was operated 300 hours on detergent oil



Photographs courtesy Standard Oil Company (New Jersey)

Piston ring grooves respond well to detergents—300 hour runs on (left) detergent, and (right) non-detergent oils

improve on properties already possessed by the oil. Various classifications of additives have been made. From the standpoint of engine cleanliness, the most important classes are detergents or dispersing agents, anti-oxidants, and anti-foaming agents. Besides these, there are oiliness or extreme pressure agents, pour depressants, and viscosity controllers.

Adding modifying agents to petroleum oils is not in itself new. "Compounded" oils, dating from the early days of petroleum, are related to oils containing additives. Perhaps one of the first motor oil additives, in the modern sense, was Parafflow, a synthetic-wax-naphthalene compound which altered the way in which wax crystallized in lubricating oil on chilling. With it, oil remained fluid far below its normal solidification temperature or "pour point." Detergency and other features of modern heavy-duty oils were not, however, considered at that time.

DETERGENTS—The function of detergents is to maintain an engine in a clean condition in spite of such contaminants as soot collected in the crankcase oil from combustion chamber blow-by, oil partially burned to carbonaceous material, and other oxidation products. These contaminants, in the absence of a detergent, would gradually accumulate as troublesome carbon, sludge, or varnish deposits on engine parts. With a detergent, they remain dispersed in the oil, or else deposit as a harmless, fluffy sediment. In the case of an engine already fouled by operation with a non-detergent oil, a detergent should help to clean the engine.

Some oils possess natural detergent properties to a greater extent than others. Early in the development of additives, only the

naphthenic type of oils—those possessing relatively high detergency—could be improved by added detergents. Newer detergents, however, are effective in all types of lubricating oils, making it possible to take advantage of any desired characteristics inherent in lubricating oils from different crudes.

One of the most important properties of a detergent or dispersing agent is the ability to hold finely divided solid particles dispersed throughout the oil. Mechanically, the result is similar to the action of soapy water. Soap in water lowers the inter-facial tension between water and dirt particles. This allows wetting of the insoluble particles so they may be held dispersed in the water. In a like manner, detergents enable oil to wet and hold in dispersion the particles of impurities that find their way into the crankcase. In an engine, dispersing agents hinder the settling of sooty material or carbon particles; they hold them in the oil where they can be drained out, and thus prevent their retention in the engine.

To be satisfactory as an oil detergent, a substance must not impair lubrication. Equally important, it must have a high boiling point, otherwise it will evaporate so fast as to become ineffective at engine operating temperatures. For example, a detergent that evaporated readily at 300 degrees, Fahrenheit, would not adequately wash hot engine parts and inhibit formation of varnish. High boiling points together with high solvency characteristics are prime requirements for detergents. On the other hand, the solvency characteristics of an effective detergent for lubricating oil must not be such that it will remove the lubricant from metal surfaces.

The chemical constitution of additives gives little indication of their action. Detergents or dispersants in-

clude chemical compounds of almost every type, although some of the more effective appear to be metallic derivatives of organic compounds, often with sulfur somewhere in the molecule. Among substances patented for use as detergents have been organo-metallic and other metal compounds, metal phenolates, acids, esters, various condensation products, and others.

To satisfy the dual requirement of solubility in oil plus high boiling points, detergents are generally high molecular weight compounds. Metal components of the molecules that have been suggested include aluminum, barium, calcium, cobalt, and magnesium. Barium compounds of alkylated phenols, sometimes further converted to sulfides, are among patented detergent additives.

ANTI-OXIDANTS — Oxidation of lubricating oils causes the formation of varnish on pistons, sludge, deposits of various sorts, and organic acids corrosive to bearing metals. High resistance to oxidation is, therefore, one of the most important characteristics of an oil. Indeed, much of the need for detergents and dispersing agents comes from the undesirable products of oil oxidation. And where an oil is highly refined to reduce the formation of these products, corrosive acids may develop in the oil in service. The purpose of anti-oxidants is to inhibit oxidation of the oil under crankcase conditions.

Anti-oxidants have long been studied for turbine oils and transformer oils where a very long useful life is expected of the oil. Consequently, anti-oxidants represent the largest single field of patented additives. Anti-oxidants, or inhibitors, are really negative catalysts that prevent oxygen in the air from attacking the oil. Chemicals suggested for this purpose include sul-

sulfur and sulfur compounds of various types such as sulfides, hydroxy sulfides, and many others, amines and other nitrogen compounds, phenols, phosphorous compounds, organo-metallic and other metallic compounds, plus many miscellaneous agents.

By combining detergency, dispersing ability, and oxidation inhibition, "inhibitor-dispersant" type motor oils were made that gave outstanding service during the war. Inhibitor-dispersants can be used effectively in any type of motor oil whether it is more or less highly refined and whether it is of paraffinic or naphthenic base crude. They can increase the service and dependability of any motor oil, especially under severe conditions. In short, these additives can give results that are otherwise unobtainable even with the best oil the refiner can produce.

Additives sometimes have a tendency to make oils foam when agitated with air. Factors of surface tension, which make the additives effective, also favor foaming. Foaming may be injurious through loss of oil or, where less severe, by reducing the crankcase oil surface cooling capacity, resulting in increased crankcase oil temperature. Although many substances have been tested as anti-foaming agents, by far the most effective are certain silicones of which a small fraction of 1 percent is sufficient to prevent foam formation.

OTHER ADDITIVES—Cold weather starting may depend wholly upon the viscosity of the crankcase oil at the existing temperature. Viscosity increases markedly between normal summer temperatures and zero degrees, Fahrenheit. The extent of these changes in viscosity with temperature is termed Viscosity Index or "V. I." The best natural lubricating oils from paraffin base crudes have about 100 V. I. as compared with much lower V. I.'s for other types of lubricating oils, whose characteristics vary more seriously with temperature changes. Although original detergent type oils were of low V. I., newer type additives are able to make good detergent oils from high V. I. lubricating oils. However, highly treated paraffin type natural lubricating oils cannot be made to have much over 100 V. I. For higher V. I.'s, special additives are required. Among the first of these were polybutenes—thick, sticky substances made by polymerization of refinery gases. These substances, when dissolved in oils, raise the viscosity of the oils somewhat, but raise the V. I. to a much greater

extent. Certain esters and other non-hydrocarbon materials are also effective V. I. improvers.

For oiliness agents, extreme pressure agents, and pour point depressants, a large number of additives have been suggested. Additives for the first two include sulfur compounds, halogen compounds, phosphorous compounds, oxygen compounds, metal compounds, and miscellaneous substances. For pour point depressants they include hydrocarbons, halogen compounds, oxygen compounds, nitrogen compounds, metal compounds, and other materials. Crankcase oils, whether for high-speed automotive Diesels or heavy-duty gasoline engines, do not require extreme pressure additives. However, some investigators claim added lubrication value and lower wear from the use of oiliness additives. Pour point depressants, on the other hand, particularly the wax-paraffin hydrocarbon additives, have been quite generally used in motor oils. For the most part, individual additives have specific properties, but efforts are being made to prepare single complicated compounds that might have several different characteristics.

COMMERCIAL "H-D" OILS — For peace-time use, motor oils containing additives have been grouped, by the American Petroleum Institute, into two classes: "Heavy-Duty Oils" which meet the military specifications, as established during the war for all-purpose heavy-duty oils; and "Premium Oils" which must show good oxidation and bearing corrosion resistance, but permit less dispersant effect than called for in Heavy-Duty Oils.

Use of these motor oil additives is another illustration of the trend toward making special products for special uses. Petroleum refiners no longer depend completely upon the gasoline existing in crude oil for the quantity and quality of the aviation gasoline they require, but through cracking and synthesizing they make additional quantities of gasoline of superior quality. Similarly, refiners no longer need depend upon the specific type of crude oil for the final quality of the lubricating oils they manufacture. By severe refining of lubricating oil stocks, the refined oil is completely free of any impurities harmful to its use as a lubricant. Through additives, the quality of the oil is then made to excel the best oil that could be obtained directly from any crude source. The demand for improved performance of motor oils has arisen from the new standards of performance developed during the war and the con-

tinuous gradual shift to engine design and operating conditions that are harder on the oil. Improved oil is coming from the petroleum industry's new source of quality and performance—chemical additives.



CORN EARWORM

*Stopped by Mechanical
Injection of Oil Mixture*

INJECTING a very small amount of a heavy, highly refined mineral oil combined with an insecticide into the silk channels of sweet corn is the most effective and practical means available for combating corn earworm, according to reports from the New York State Agricultural Experiment Station.

"While further experimental work toward better control methods is in progress," says Dr. L. A. Carruth, Station entomologist, "this form of control of the corn earworm deserves wider usage by growers in sections where the pest is a problem."

Ordinarily, the insect is most troublesome on Long Island and other areas near New York City, although it may appear in serious numbers in other sweet-corn growing sections of the state as well. The pest is generally most serious from mid-August to the end of the growing season. The mineral oil treatment involves the individual treatment of each ear with a carefully measured quantity of the oil-insecticide preparation about four days after the emergence of the silks. Best results have been obtained with mixtures containing pyrethrum, dichlorethyl ether, or styrene dibromide as the active ingredient. Commercial oil-insecticide mixtures for this purpose are now available.

The maximum dosage permissible without danger of injury to the ear is one-fiftieth fluid ounce, and some sort of mechanical applicator is required to insure the correct dosage. On this basis, a gallon of the oil-insecticide combination should treat 6400 ears, or more than half the average production of an acre of sweet corn. The time required depends on the operator, but it should be possible to treat from 1000 to 1200 ears an hour, says Dr. Carruth. Unfortunately, this treatment will have no effect on the European corn borer nor will control measures aimed at the corn borer have any effect on the corn earworm, it is explained.

Plastics Precede Production

Familiar to All in Their Manifold Applications as Finished Products, Plastics Aren't so Well Known as Highly Usable Experimental Materials. Here, an Inventor Plans with Plastics and Develops a Meat-Saving Germicidal Lamp Unit. Casting Plastics Paved Way for Molded Product

By CLARK SIMMONS

WHEN A MAN engaged in the meat-cutting equipment business—producing saws, cube-steak machines, and like items—combines his energies and perseverance with some of the latest scientific developments, it is natural, perhaps, that the appliance he perfects will have direct implications to the meat industry. At least that's what happened when J. L. Suter started working on a new unit for standard germicidal lamps that would stand up under meat-cooler conditions of low temperature and high humidity. When he finished, the lamp spelled lower cold-storage losses to meat-market operators, and promises wide uses in other places.

The need for such an appliance is not, of course, new. Meat deterioration from mold, shrinkage,

and odors is an old problem. Neither are germicidal lamps entirely new; it has been recognized for some time that ultra-violet rays will reduce losses during meat storage. But two things were new, or at least clever, about Mr. Suter's development. One was the way he used casting plastics for experimenting on the limited means available to him. The other was the successful solving of the moisture and corrosion problems that occur when an electrical device is placed in the atmosphere of a meat cooler.

Fundamentally, the success of the lamp unit depended upon finding a suitable design and material for fixtures to house the miniature transformer, starter mechanism, and wiring located at each end of the standard tube-shaped lamp. The housing fixture caps had to provide a maxi-

● LOOKING AHEAD ●

Small manufacturers and experimenters, and large ones too, will find wider usage for casting resins. . . Low-cost plaster molds combine with complete formability of the resins to allow complex shapes in otherwise expensive experimental parts. . . Not to be overlooked are the possibilities for quickly-made production jigs of the same casting resins.

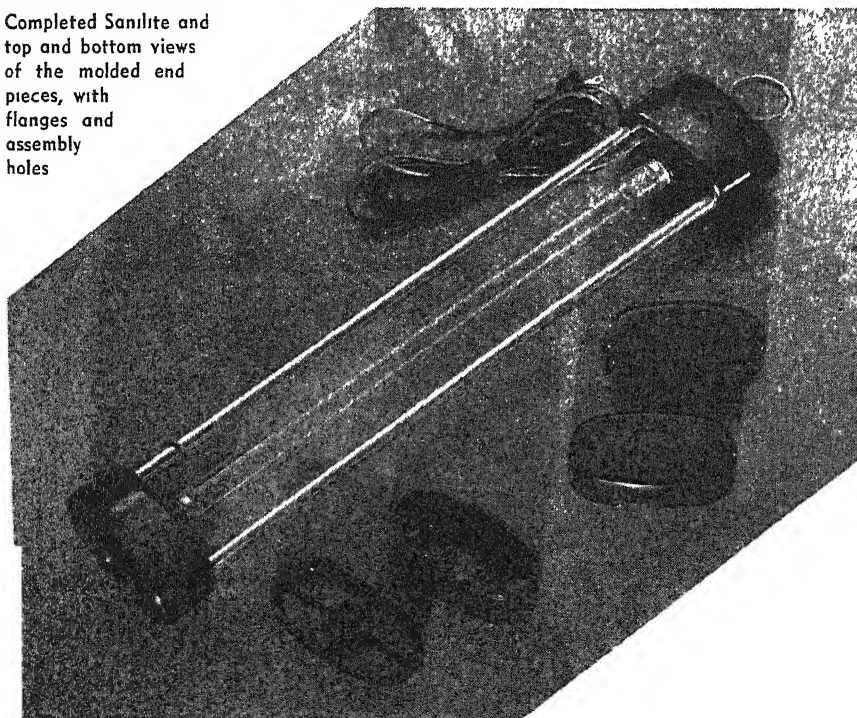
mum of protection against the low temperatures and relatively high humidities which Mr. Suter knew existed in refrigerators and meat show-cases. Furthermore, the fixture cap material had to lend itself to quick and economical production. Clearly, research was necessary.

When the basic design problems of the fixture caps had been worked out on paper, several sets of experimental caps were made up from a casting resin, using inexpensive plaster-of-Paris molds. Use of this Durez phenolic casting resin gave a flexible and easily handled material. Moreover, according to Mr. Suter, the economy and suitability of the material for small scale experiments were largely responsible for his ultimate success in developing the Sanilite lamp unit into a mass-producible article.

Changes had to be made in the experimental fixtures. Sometimes, the changes were small, and the excellent machinability of the casting resin permitted them to be worked in without recasting. Sometimes, problems showed up that required starting over with new castings for further tests. But Mr. Suter went on; many sets of caps were cast and finally the last design-bugs were eliminated. Now, since casting resin was not an economical production material, the problem changed to the selection of a substance suitable for quantity production runs of the fixture caps.

Plainly, conditions indicated a non-hygroscopic material with first grade dielectric qualities. Stainless steel rods carrying electrical wires ran end to end on the lamp unit,

Completed Sanilite and top and bottom views of the molded end pieces, with flanges and assembly holes



and these had to be embedded in the end fixtures with a moisture-proof joint. Non-corrosiveness, low thermal expansion characteristics, and self insulation were "musts." Therefore, it was decided to mold the cap fixtures of Durez phenolic molding compound which also possessed the desired properties.

Each cap was designed in two halves. Molding allowed the required flanges to be integral and the assembly-hole openings did not have to be drilled later. Orders for steel molds were placed. The details, worked out in casting resin, were known to be correct. Production got under way, and the four molded pieces for the lamp unit, the results of so much effort and experiment, are now being made for the Sanilite Company by the Grigolet Company.

On the assembly line, Mr. Suter once more loosed his ingenuity with the casting resin—this time to make up quick and inexpensive jigs. The characteristics of this material made it possible to cast a jig and have it in operation in less time than would be required to make up the drawings for a part fabricated from more conventional materials.

From the standpoint of the butcher who uses Suter's Sanilite unit in his show-cases and refrigerator, the hard work and experiment were something more than worthwhile. The ultra-violet rays emitted by the lamp prevent slime and mold from forming on the meats. Odors are thus eliminated and coolers may be operated at substantially higher temperatures, reducing both meat shrinkage and cooler operating expense. The unit is trouble-free due to its moisture-proof construction and resistance to the corrosion found in meat coolers.

The lamp unit should find other applications in such places as food processing plants, hospitals, and schools; nearly anywhere, in fact, where a sterile atmosphere is desirable. Sanilite is one of these "small business" developments that has succeeded—in the words of the developer and producer—"thanks to the co-operation of the plastics manufacturer and molder."

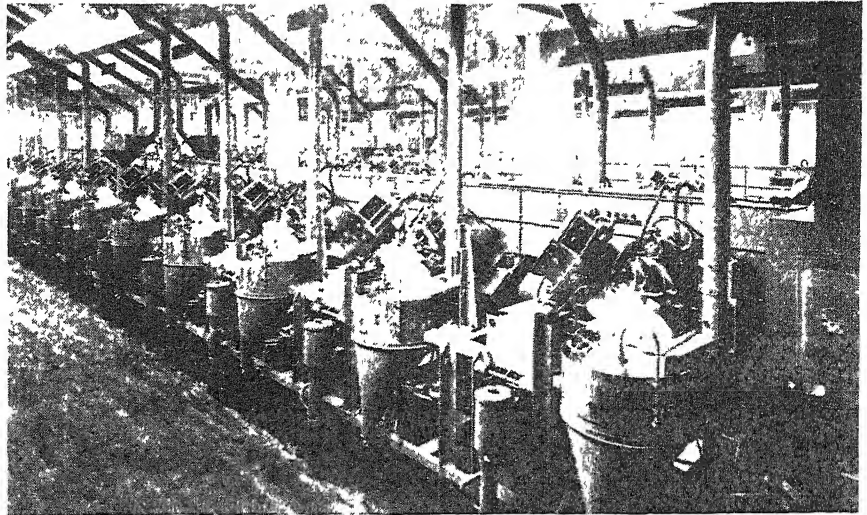
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BEAN SORTING

*Only One of Many Jobs
Now Done Automatically*

AIDED BY one of the growing industrial uses of electron tubes, the formerly tedious task of sorting beans—and other things—now becomes a speedy, automatic operation.

Equipped with a couple of photo-



A bank of electronic bean sorters—separation is based on beans' color range

tubes for eyes and a cathode-ray tube for a brain, the electronic sorting machine, according to the Tube Division of the Radio Corporation of America, "looks" at each bean individually and separates the good ones from the bad ones much faster and more accurately than could human sorters.

Approximately 1000 of these "super sorters," all manufactured by the Electric Sorting Machine Company, are now sorting about one and one-half million pounds of food each day in plants from California to Virginia and in Canada. Each installation consists of at least 16 machines. The foods include beans of various kinds, seed corn, peanuts, coffee, and even potatoes.

In the sorting of beans, for example, acceptance or rejection of each one depends on the respective percentages of red and green light reflected by it. The mechanical design of the machine provides for feeding the beans, one at a time, through an optical system consisting of an incandescent lamp, a focusing lens, two mirrors, and two phototubes.

Light from the lamp is reflected by the bean through the lens to the first of the two mirrors. This mirror is what is known as a "partial" mirror or "50 percent" mirror. It reflects part of the light through a red color filter to the first phototube, but transmits another part of the light to the second mirror, which reflects it through a green color filter to the second phototube. The first phototube is especially sensitive to red light, the second to green light.

The output of each phototube is amplified and fed to one of the two pairs of deflection plates of a cathode-ray tube. This permits one phototube to control the horizontal sweep of the electron beam in the cathode-ray tube, while the other phototube controls the vertical

sweep of the beam. The degree to which the beam is deflected in either direction is governed by the respective amounts of red and green light reaching the phototubes.

A partial mask covers that part of the face of the cathode-ray tube on which the electron beam will appear when controlled by the color range of an acceptable bean. When a bad bean passes through the optical system, the color of the reflected light affects the output of the phototubes, and this in turn alters the sweep of the electron beam so that it appears outside the mask. Any position of the electron beam outside of the masked area actuates a third phototube whose output is amplified to operate an ejector mechanism which rejects the faulty bean.

Although the steps involved seem numerous in a description, the action is virtually instantaneous. The sorting of foodstuffs is one of the long and growing list of industrial applications in which electron tubes are doing a better, surer, more accurate job, in addition to effecting dramatic savings of time, labor, and operating space.

STABILIZED RAYON

*Produced by New
Chemical Treatment*

RAYON FABRICS that are fully washable are promised by a new stabilizing finish called "Definized."

Thus far the "Definized" procedure is reported to reduce dimensional change in rayon fabrics to 1 percent or less; indications are that this is the percentage of residual shrinkage which will apply to fabrics processed with this new chemical finish.

Because rayon fabrics may be "Definized" simply by applying special chemicals in the finishing process, there are no complicated manufacturing problems. According

to the Aqua-Sec Corporation. finished "Definized" articles put on the market will be appropriately labeled for consumer identification. The corporation further states that the "Definized" process means that the apparel industry using rayons can now cut and manufacture garments to size. No longer need so-called washable rayon garments come in "large," "medium," and "small" sizes only, nor need manufacturers allow for shrinkage or stretching in cutting garments. At the same time, "Definized" does not alter the feel, appearance, or the character of the rayon fabric.

BUS DISPATCHING

*Expedited by Radio-
'Phone Installation*

TWO-WAY radiotelephone equipment is currently being used by the Greyhound Bus Lines of Chicago, Illinois, on an experimental basis for dispatching and maintaining contact with buses while en route.

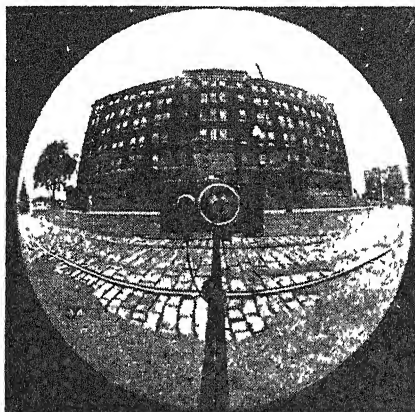
The bus lines have long faced the problem of a lack of communication with buses in service, because a bus, like an airplane, is usually not reported from departure until arrival at its destination. The function of the radiotelephone would be mainly

have been made up to 50 miles, and transmission from the buses to the fixed station have been received up to 80 miles.

ILLUMINAGRAPHIC

*Camera Measures Light
In Given Area*

A CRYSTAL-GAZING camera which, minus swami garb, peeks into a convex mirror and photographs measurable light reflected therein,



Distortion is normal to new camera with mathematical, not artistic, uses

has been devised by Frank Benford, physicist in the General Electric research laboratory, and is technically called an "illuminagraphic" camera. The new instrument eliminates complicated computations in spherical trigonometry heretofore necessary for measuring light in a given area. This simplified system of measure, according to Mr. Benford, will enable illuminating engineers and architects to easily obtain data from which structures can be designed wherein maximum light is provided.

The instrument consists of an ordinary, small camera mounted directly above a convex mirror, which at casual glance could pass for the top of a swami's crystal ball. Perimeter of the mirror, instead of being perfectly spherical, is deliberately curved in such a manner that the distorted reflection of any light source in it is directly proportional in size to the illuminating value of that light source. This process of so reflecting light is called "double projection," according to Mr. Benford.

The peculiar curvature permits the mirror to reflect everything in a given area above the level of the mirror. Thus, at any point where the instrument is placed, the crystal-gazing camera can photograph a complete picture of light being received at that point.

From the photograph, the area of light surfaces is measured against the total area of the picture. The

percentage of light in the picture thus computed also is the percentage of light being received at that point from the various light sources since the photographed reflections are directly proportional in size to the effectiveness in size of the light sources.

With sources of artificial illumination a known quantity, and with standard averages for sky brightness available, the exact amount of foot lamberts of light at that particular place can be computed.

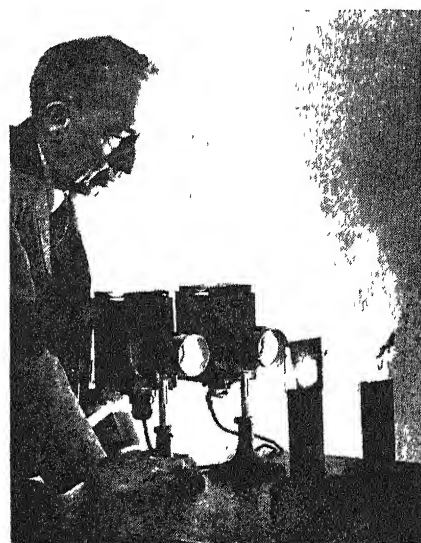
Because of the convex mirror, photographs taken resemble images seen in mirrors at an amusement park fun-house. Railroad tracks appear undulating, telephone poles cursive gracefully, and solid, block long buildings become narrow skyscrapers.

Using an illuminagraphic process, illuminating engineers will be able to evaluate scientifically the actual lighting worth of present types of illumination, according to Mr. Benford. They will be able to estimate accurately the effect on lighting of various types of walls and ceilings, windows and window frames, alcoves, and other physical building properties. The illuminagraphic camera should aid in the design of new types of lighting and new planning for buildings, rooms, and offices, Mr. Benford claims.

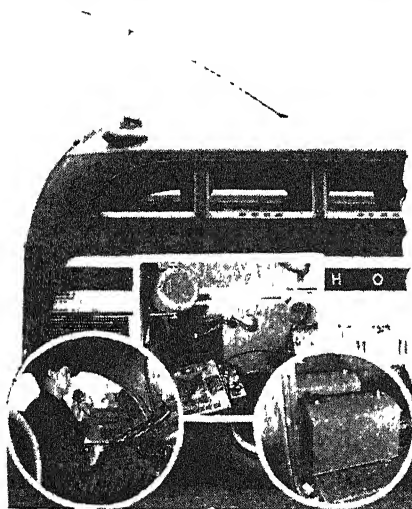
HEAT ABSORBING

*Glass Transmits Light
With High Efficiency*

IMPROVED projection of color pictures and cooler working conditions for motion picture and television actors are possibilities promised by a new heat-absorbing, color-transmitting



Proof of heat-absorbing power of new glass for color projector shielding. Film in pedestal on left, shielded by it, does not burn. Film on right has an ordinary shield; is ignited by heat



Radio unit parts are: (left) "Mike," (center) controls, and (right) transmitter. Antenna mounts above the bus

to give location of the buses on the highways, advise of delays, and, in emergencies, to provide rapid assistance to any bus in trouble and handle other details incident to highway bus control.

The equipment being used is the standard 50-watt Motorola mobile, police-type, two-way radiotelephone and operated in the 30-44 megacycle frequency band. At the terminal station is a Motorola FM transmitter-receiver of 250-watts output power. Two-way contacts

glass announced recently by American Optical Company. Dr. E. D. Tillyer, research director, says that the new glass, when used as a heat screen in a projector, absorbs heat emitted by the light source so that films and slides are protected against damage or burning. This insulating property, he adds, enables film editors and educators to study a specific projected scene by stopping the projector and relying on the heat-absorbing glass screen to protect the film.

The glass can also be used in spotlights and floodlights as a heat screen to protect movie and television actors against scorching heat generated by the powerful lights. Approximately 90 percent of the heat is absorbed by the glass.

Development of the glass, according to Dr. Tillyer, makes possible improved, safe color projection on an extended scale in homes, schools, theatres, and stores. In the post-war world, he predicts, projection of films, slides, printed works, and color reproductions of works of art will be as common in schools and homes as the reception of radio broadcasts is today.

"The new glass," he states, "absorbs approximately 90 percent of infra-red (heat) radiations and transmits approximately 85 percent of light out of a possible 92 percent (8 percent is always lost by reflections). If reflections are reduced by glare-removing methods, light transmission can be increased from 85 to 90 percent."

The glass is reported to transmit colors accurately, to be chemically stable, and to resist weathering without requiring a surfacing treatment. It can be molded, ground, and polished, and fabricated like ordinary glass. It is formed from carefully balanced proportions of phosphorus, aluminum, and silicon oxides, supplemented by various conditioning ingredients together with ferrous iron as the heat-absorbing agent.

SMALL SHOPS

*Point the Way to
One-Man Industries*

A MODEL machine shop suitable for one-man operation which requires but little space, has been designed by Leighton Wilkie, chairman of The DoALL Company. The model is one of eight types of service and repair shops prepared by industrial planning engineers of the company to assist veterans with mechanical skills who desire to go into business for themselves.

"With big industry unable to maintain employment levels at war-



One of eight model service and repair shops planned by industrial engineers to assist returned service men who want to go into business for themselves. This well-designed machine shop can be housed back of a store, in a two-car garage, in a basement, or wherever space is available. The equipment includes: (1) a contour sawing machine; (2) supply cabinet; (3) drill press; (4) tool cabinet; (5) lathe; (6) arbor press; (7) bench drill press; (8) toolmaker's bench; (9) vise; (10) bench plate; (11) tool grinder; (12) anvil; (13) electric arc welder; (14) oxyacetylene welder; (15) rough bench; (16) vise; and (17) stock storage rack. Equipment is arranged for maximum utility.

time peak," Wilkie stated, "the organization of new small enterprises of this kind appears to be the logical answer to employment of the nation's manpower."

Although the various types of shops are designed primarily for repair and service work in any of the thousands of communities scattered from coast to coast, ambitious operators, Wilkie points out, may readily expand into small specialty parts manufacturing, and from this point, they may follow logical expansion into large modern industries producing industrial and consumer goods.

HAM RADIO

*Offers Possible Profit
As Well as Public Service*

RETURNING servicemen with wartime communications training are being advised by the American Radio Relay League to enter the field of amateur radio. One reason is because this hobby of self-training often is the stepping stone to professional radio engineering or manufacturing. For example:

Ivan Farman began his radio ca-

reer in 1914 with a spark coil transmitter and his amateur station 6MG; today Brigadier General Farman runs the worldwide network of Army Airways Communications System. Edwin H. Armstrong, inventor of frequency-modulation broadcasting, spent many of his younger days operating amateur station 1BCG. Bill Eitel and Jack McCullough were radio "hams" in southern California when they hit on new ideas for vacuum tube construction; today the Eimac plants employ hundreds of people and have turned out many thousands of high-power tubes for military radio. Jack DeWitt is well-known in amateur circles as operator of W4ERI; as Lieutenant Colonel J. H. DeWitt, he recently won fame as supervisor of the Signal Corps' successful attempt to obtain radar echoes from the moon. The million-dollar Collins Radio Company was formed in 1931, but its real history goes back to the middle twenties when young "Art" Collins was experimenting in transmitter design at his personal station, W9CXX.

The institution of amateur radio, like most hobbies, provides its fol-

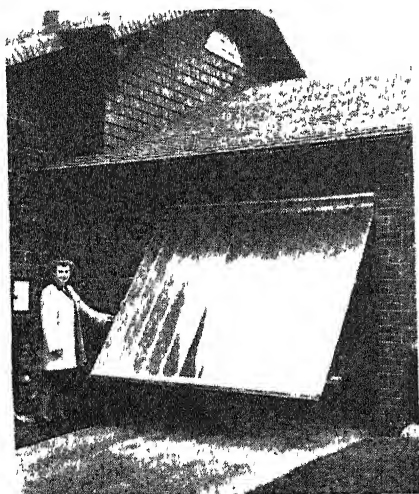
lowers with that priceless intangible which the League, national association of "ham" operators, chooses to call "the amateur spirit in research." The professional man who is also an amateur does his work for the love of it, they point out. Not confined to a formal knowledge of radio phenomena, such a man has the inquiring mind, the unfettered viewpoint which often gets otherwise unobtainable results.

The League also invites the interest of returning communications servicemen because amateur radio has long been traditionally charged with the responsibility of furnishing a vast reservoir of equipment and trained personnel to set up communications systems for use in case of disaster. Further, in time of national emergency, volunteering amateurs can be made crack military operators and technicians with but a slight amount of additional training, a fact proved again during the early period of the recent war.

GARAGE DOOR

*Has Self-Contained
Operating Mechanism*

WHEN more room is needed in a garage, a newly developed aluminum overhead door will often solve the problem. This new door does away



Light-weight door operates easily

with all tracks, weights, and exposed springs inside the garage. The entire operating mechanism of the Berry door is enclosed in a small box installed on the back of the door. It is reported that it can be installed, ready to use, in less than 30 minutes.

TOOL CONTROL

*Accomplished by Sensitive
Electronic Set-Up*

AN "electronic finger" which automatically controls the operation of a machine tool can be used on work ranging from shaping graceful can-

dlesticks to forming supercharger housings for aircraft engines. In fact, almost anything that can be cut with a motor-driven tool from a pattern or template can be produced accurately and completely automatically with a machine equipped with this versatile device which literally has a "sense of touch."

The vital part of this control device is an "electronic finger" which feels its way around the angles and curves of a pattern to control the operation of the cutting tool.

This feeler or tracing stylus comprises, in electrical terms, two magnetic bridges, each consisting of two identical magnetic circuits, one pair mounted on an axis at right angles to the other pair. The four magnetic poles are assembled on a diaphragm which is fastened to the stylus, a finger-like projection which touches the pattern or template.

In operation, the stylus of the tracing head is moved against the side of the contour on the pattern to be reproduced. The very slight pressure of the feeler against the template causes a deflection of the diaphragm which in turn creates a change in voltage in the coils of the tracing head. This voltage is then carried to the "brain" of the entire device, where the signals from the bridge circuits are amplified many times and "mixed" into what is called a vector signal—a signal which is related to the direction of the pressure on the stylus. This signal causes the stylus to be driven against the template. As the deflection of the stylus increases, the vector signal is shifted by a "bender" circuit to cause the stylus to move along the surface of the template with a uniform deflection.

The signal from the "bender" circuit is sent into a translator circuit which produces two separate d.c. voltages. Each voltage determines the speed of one of the two feed motors. These voltages are so coordinated that the resultant speed of the stylus around the template is constant, regardless of the direction. When a change in contour is encountered, one motor will automatically slow down or speed up just the proper amount to reproduce on the piece of work in the machine the same contour encountered by the stylus on the pattern.

Rapid changes in the direction of machine motion are dependent on fast motor control. The thyatron tube, also a General Electric development, provides the means for controlling motor speed and direction from the translator circuit signals—and almost instantaneously. So sensitive is the control over the



Precision contours for supercharger housing or delicately shaped candlesticks are accurately duplicated from master pattern by "electronic finger"

motors, that each can be stopped or started in less than an eighth of a second.

Extremely simple to operate, General Electric's new control can be applied to many different types of metal cutting tools and is capable of a variety of intricate cutting operations.

CONDUCTING RUBBER

*Seen as an Efficient Means
of Electrical Heating*

RUBBER is an excellent material for electrically heating many parts on airplanes with which difficulty is encountered in the extreme cold of high altitudes, according to The B. F. Goodrich Company.

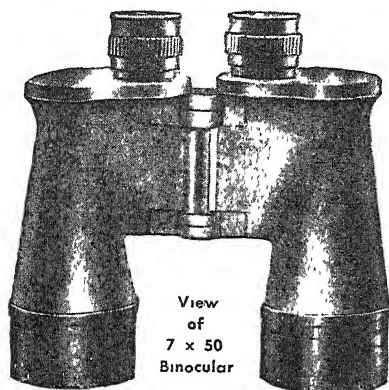
Most engineers, including those in aviation, are accustomed to thinking of rubber as a non-conductor of electricity, but such is not always the case. Special compounding changes the characteristics of the rubber so that it can be used in some applications as a conductor and in other cases as an insulating covering for conducting compounds or for other electrical heating elements.

Among applications where rubber has been effectively used to provide heat are some hydraulically operated plane parts where the fluid has to be kept warm for efficient operation. A conducting rubber shoe is placed over the spot to be warmed and electrical current does the job.

Because rubber can be molded to almost any shape, the company points out that literally anything on the plane can be heated by such methods, and complete, as well as spot heating, can be accomplished. Hydraulic, water, or steam lines, can be fully covered and uniform temperatures throughout obtained by the application of rubber and electricity.

SENSATIONAL WAR BARGAINS in LENSES and PRISMS

NOW! MAKE YOUR OWN BINOCULARS!



FLASH! JUST RECEIVED!

Metal Parts and Bodies for Navy's
7x50 Binoculars

You get a Right and Left Body, 2 Objective Mounts, Left and Right Prism Shelves, Right and Left Cover Plate for Eye Piece mounting, miscellaneous Screws and Parts. This assortment represents nearly all the main parts you'll need for your Binocular construction. It's truly an exceptional War Surplus opportunity.

Stock #804-S—Binocular Parts Set \$10 00 Postpaid
Stock #805-S—Monocular Parts Set 5 50 Postpaid

Complete Sets of LENSES and PRISMS
from Navy's 7x50 Model

Save Up to \$150.00!

Here's an unusual opportunity to secure a fine set of Binoculars at a tremendous saving of money. Build them yourself with all of the very same optics contained in the Navy's 7 Power Glasses the Binoculars which received such wide acclaim during the war. Depending on your choice, you may buy a perfect set of Lenses and Prisms for the Binocular construction job, or a set of seconds (exactly the same units, but Lenses are unmounted and have slight imperfections). If however, you wish to construct a Monocular (1/2 a Binocular) you may do so, choosing either perfect components or seconds. The Monocular sets comprise 1/2 quantities of the same optics required for the Binocular. The full perfect Binocular set comprises the following: 2 Cemented Achromatic Eye Piece Lenses, 17.5 mm diam., 2 Eye Field Lenses, 4 Porro Prisms, 2 Cemented Achromatic Objective Lenses, diam 52 mm. Complete assembly directions included.

Stock #5102-S—
Perfect Binocular Set \$25 00 Postpaid
Stock #5103-S—
Perfect Monocular Set 12 50 Postpaid
Stock #5105-S—
Seconds for Binoculars 11 00 Postpaid
Stock #5104-S—
Seconds for Monocular 5 50 Postpaid

NOTICE! If you buy both the Binocular Optics and the Binocular Metal Parts, your purchase becomes subject to 20% Federal Excise Tax. Be sure to add amount covering tax to your remittance or your order cannot be filled.

All Items Finely Ground and Polished but Edges Slightly Chipped or Other Slight Imperfections Which We Guarantee Will Not Interfere with Their Use. Come Neatly Packed and Marked.

TO KEEP POSTED on all our new Optical Items, send 10c and your name and address to get on our regular "Flash" mailing list.

MICROSCOPE SETS

Consisting of two Achromatic Lenses and two Convex Eye Piece Lenses which you can use to make a 40 Power Pocket Microscope, or 140 Power Regular Size Microscope. These color corrected Lenses will give you excellent definition.

Stock No 1052-S \$3 00 Postpaid

Consisting of Prism, Mirror and Condensing Lens. These used together with Stock No 1052-S will make an excellent Micro projector, enabling you to get screen magnification of 400 to 1000 Power according to screen distance.

Stock No 1038-S \$2 00 Postpaid

BIG DOUBLE CONVEX LENS—74 mm diam 99 mm F.L. Weighs 9 oz. Made of borosilicate Crown Optical Glass. Used as spotlight Lens, Condensing Lens, etc.

Stock No 1048-S \$1 50 Postpaid

BIG DOUBLE CONCAVE LENS—74 mm diam 110 mm F.L. Made of extra dense Flint. Used as reducing Lens, for truck photography, etc.

Stock No 1049-S \$1 00 Postpaid

OPTICS FROM 4-POWER PANORAMIC TELESCOPE—Excellent condition. Consists of Objective Prism, Dove Prism, Achromatic Objective Lens, Amici Roof Prism, Eye Lens Set (value \$60 00).

Stock No 5016-S \$6 00 Postpaid

LENS CLEANING TISSUE—In spite of paper shortage, we offer an exceptional bargain in first quality Lens Cleaning Tissue. You get 3 to 4 times as much tissue as when you buy in the ordinary small booklets. One ream—480 sheets, size 7 3/4" x 10 3/4".

Stock No 704-S \$1 50 Postpaid

RAW OPTICAL GLASS

An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint glass (seconds) in varying stages of processing. Many prism blanks.

Stock No 703-S—8 lbs (min wt)—\$3 00 Postpaid

Stock No 702-S—1 1/2 lbs \$1 00 Postpaid

MISCELLANEOUS ITEMS

Stock No Item Price

1031-S—6 Power Magnifier—Diam 29 mm .25

Each .25

2043-S—Standard Crossline Reticle—Diam 29 mm .50

Each .25

1034-S—Burning Glass Lens Each .25

2024-S—10 Pieces Circular A-1 Plate Glass (Diam 31 mm—for making Filter) .25

323-S—Srv Threaded Metal Reticle Cells .25

674-S—Neutral Ray Filter size 4 1/4" x 2 1/2" .25

1009-S—Round Wedge, 65 mm Diam Each 5 00

3021-S—Amici Roof Prism (3rd grade) Each .25

72-S—Eye Lens 48 mm long .20

1010-S—2" Diam Reducing Lens Each .25

(Minimum Order on Above—\$1 00)

TANK PRISMS PLAIN OR SILVERED

90-15-45 deg 5 1/4" long, 2 1/8" wide finely ground and polished. Would normally retail from \$24 to \$30 each.

Stock #3100-S—Silvered Prism \$1 00 Postpaid

Stock #3101-S—Plain Prism \$1 00 Postpaid

Illustrated Book on Prisms included FREE

TANK PERISCOPE

Complete Set Mounted Components for U.S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Would normally retail at \$40 to \$50. Stock No 700-S \$2 00 Complete Set Postpaid.

SPECIALS IN LENS SETS

Set #1-S—"Our Advertising Special"—15 Lenses for \$1 60 Postpaid, plus 10-page idea booklet. For copying, ULTRA CLOSE-UP SHOTS, macrophotography, experimental optics, magnifying and for making a two power 1/16 Telephoto Lens, "Dummy Camera," Kodachrome viewer, DETACHABLE REFLEX VIEWFINDER for 35 mm cameras, stereoscopic viewer, ground glass and enlarging focusing aids. TELESCOPES, low Power Microscopes and for many other uses.

NEW 50-PAGE IDEA BOOK "FUN WITH CHIPPED EDGE LENSES"

Contains wide variety of projects and fully covers the fascinating uses of all Lenses in sets listed above. Only \$1 00 Postpaid.

35 MM KODACHROME PROJECTING LENS SET—Consists of Achromatic Lens for projecting plus a Condensing Lens and piece of Heat Absorbing Glass with directions.

Stock No 4025-S \$1 95 Postpaid

SPECTROSCOPE SETS—These sets contain all Lenses and Prisms you need to make a Spectroscope plus FREE 15-page Instruction Booklet.

Stock No 1500-S—Hand Type Spectroscope \$7 15 Postpaid

Stock No 1501-S—Laboratory Type Spectroscope \$6 50 Postpaid

ALL THE LENSES YOU NEED TO MAKE YOUR OWN TELESCOPE!

ALL ARE ACHROMATIC LENSES

GALILEAN TYPE—Simplest to make but has narrow Field of View.

Stock #5018-S—4 Power Telescope \$1 25 Postpaid

Stock #5004-S—

Small 2 Power Pocket Scope \$1 00 Postpaid

PRISM TELESCOPES—Uses Prism instead of Lenses to Erect Image and are much shorter than Terrestrial Type. Have wide field of view.

Stock #5010-S—6 Power Telescope \$3 00 Postpaid

Stock #5012-S—20 Power Telescope 7 25 Postpaid

REMARKABLE VALUE!

\$141.01 WORTH OF
PERFECT LENSES
FOR ONLY \$10

Complete System from Artillery Scope (5X) 9 Lenses, low reflection coated, absolutely Perfect. Diameters range from 1 1/3 inches to 2 1/5 inches. Used for making Telescopes and hundreds of other uses.

Stock #5019-S \$10 00 Postpaid

ACHROMATIC LENSES

Stock No	Dia in mm	F.L. in mm	Price
6178-S	18	80	\$1 00
6179-S	23	51	1 25
6181-S	24	48	1 25
6182-S	25	122	1 25
6184-S*	26	104	80
6185-S	27	185	1 00
6186-S	29	54	1 25
6188-S	29	76	1 25
6189-S	31	122	1 50
6171-S	32	171	1 00
6173-S	34	65	1 00
6176-S	38	131	1 00
6177-S*	39	63	1 10
6178-S	47	189	1 50
6179-S*	46	78	1 25

ASTERISKED ITEMS are unmounted, but FREE cement and Directions included with unmounted sets. USES—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye Piece Lenses, Macro-photography Gadgets, Optical Instruments, etc. etc.

RETICLE SET—5 assorted, engraved reticles from U.S. Gun sights.

Stock #2035-S \$1 00 Postpaid

RIGHT ANGLE PRISM—Flint Optical Glass size 41 mm by 91 mm by 64 mm. Use in front of camera Lens to take pictures to right or left while pointing camera straight ahead. Also used in front of camera Lens to reverse image in direct positive work. Two of these Prisms will make an erecting system for a Telescope.

Stock No 3076-S \$3 00 Postpaid

MAGNIFIER SET—5 magnifying Lenses—Powers from 1 to 10.

Stock No 1026-S \$2 00 Postpaid

PRISMS

Stock No	Type	Base Width	Base Length	Price
3040-S	Right Angle	33 mm	23 mm	\$1 00
3045-S	Right Angle	70 mm	168 mm	8 00
3001-S	Lens Surface	20 mm	14 mm	2 00
3006-S	Porro-Abbe	9 mm	9 mm	25
3009-S	Porro	52 mm	25 mm	1 00
7010-S	Porro	43 mm	21 mm	50
7016-S	Pentagon	45 mm	22 mm	75
7029-S	Dove	16 mm	65 mm	1 25
7076-S	80 Degree Roof	60 mm	36 mm	4 00
7049-S	Right Angle	69 mm	167 mm	10 00
7047-S	Right Angle	53 mm	103 mm	4 00
7038-S	Roof Prism	18 mm	34 mm	2 50

Order by Set or Stock No. — Satisfaction Guaranteed — Immediate Delivery

EDMUND SALVAGE COMPANY • P.O. AUDUBON, NEW JERSEY

New Products and Processes

PELLET BLASTING

*Cleans Soft Metal
Without Abrading*

TENITE plastics pellets, blown from an ordinary blasting machine, are reported to remove completely the minute particles of dust which are given up through the pores of sand-cast aluminum-alloy castings. This method of



Plastics pellets leave satiny finish

cleaning, according to the pellet manufacturer, Tennessee Eastman Corporation, seems to draw out the dust, rather than pound it in. In addition, it imparts a satiny finish to the metal without abrasion, and is quicker and more economical than methods previously used.

The Tenite pellets employed for this purpose are similar to those supplied regularly to the plastics molding industry, although slightly smaller. As blasting agents, they have also been extensively used in blasting carbon from airplane pistons.

VISCOUS PLASTICS

*Moulded to Shape
With Little Heat*

HIGH optical and electrical properties, good resistance to abrasion and high resistance to oils, greases, and most chemicals—including acids and alkalis—are some of the characteristics of a non-flammable thermoset plastics recently introduced under the name Kriston. One of a series of new thermosetting resins, forming of this material is accomplished by polymerizing the liquid monomer in the presence of a suitable catalyst. Low temperatures and no pressure are required.

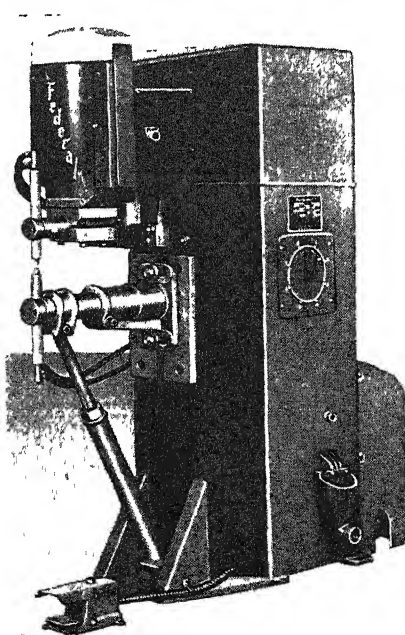
Before forming, this B. F. Goodrich Chemical Company product is a some-

what viscous, water-clear, anhydrous liquid, having a specific gravity of 1.25, that can be cast in simple molds and which sets with very low shrinkage to a hard, heat resistant plastics. No water or other volatile products are released during the process, thus aiding the preparation of dense, non-porous, odorless, tasteless, and dimensionally stable articles. The final products may be water-clear or in a wide range of colors which can be transparent, translucent, or opaque. Possible applications are optical lenses, prisms, or transparent sheets—Kriston's refractive index is somewhat higher than that of glass—electrical insulating parts, and in the chemical and processing industries where imperviousness to corrosive materials and solvents is important.

PRESS WELDER

*Uses Hydraulic Pressure;
Has Automatic Controls*

AN AUTOMATIC, hydraulically operated, press-type welder in 30, 50, and 75 KVA capacities is described as suitable for either spot or projection welding by the Federal Machine and Welder Company. Welding pressure is applied through an inverted-type hydraulic cylinder. The cylinder is a part of the slide or ram, while the piston is the so-called fixed member, its upper end being secured to the top of the welder by a heavy-duty transverse, adjustable spring. This spring serves a dual purpose by actuating a switch that initiates the timing controls and providing a



For either spot or projection welding

quick "reaction" for a fast follow-up on the welding stroke. Welding pressure is adjusted by the hydraulic pressure regulator and gage.

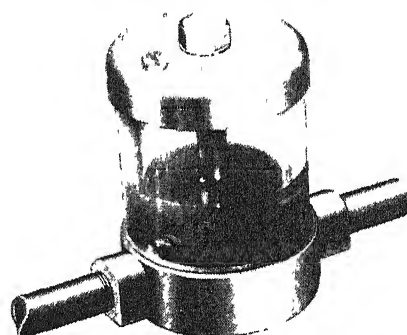
A foot switch is the only operating control, and is attached to a flexible cable which permits easy positioning for each job. A single light pressure and release puts the welder through one complete welding cycle. Welding speed is governed by timing controls. Automatic recycling continues as long as the switch is held in contact. Water cooled transformers and water cooled electrodes are standard equipment.

The welders are available in three sizes, with a working range from 26 gage to 6 gage steel sheets or comparable material.

AIR TOOL LUBRICATOR

*Has Visible Oil Supply;
Adjusts to Meet Demand*

AN AUTOMATIC lubricator for pneumatic equipment was recently announced as having several new features. These include a full-view, non-breakable transparent plastics window with "O" rings for top and bottom seals, needle valve lubricant regulation, easily adjustable to meet varying equipment requirements; and fully automatic operation. The adjustability



Transparent window is non-breakable

of the "CCA Lube" prevents oil flooding as well as oil starvation, helps eliminate freezing of pneumatic equipment, and thus tends to cut down maintenance operations. The needle valve can be turned off altogether in cases where no lubrication is required.

Small but rugged, the unit is manufactured by CCA Products Engineering.

PANEL LIGHT

*Uses "Black-Light" from
Miniature Fluorescent Tube*

UNSEEN ultra-violet rays from a fluorescent tube now promise to transform the dial markings of home radio or television receivers into uniformly-glowing colors. Primarily intended to improve dial lighting and to beautify radio sets, "black-light" is now expected to find very practical application in television where fluorescent control knobs and dials would aid visibility and reduce interference with the television image.

The tubular panel lamp itself is a simplified, miniature version of the ordinary fluorescent tube but instead

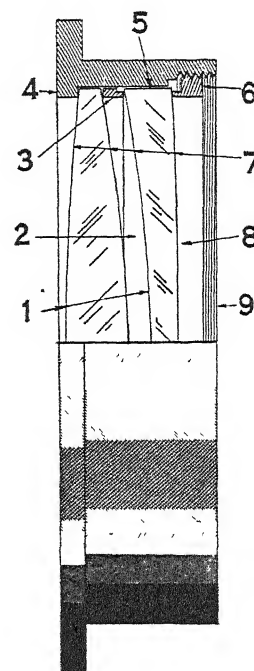
COATED 2" and 3" ASTRONOMICAL OBJECTIVES

WE ARE STARTING a production run for 2" and 3" astronomical objectives completely mounted in a flanged lens cell ready for use. We feel that there is no better objective available for the price and to support our claims we guarantee complete satisfaction or we will return your money. The following features of these objectives are noted.

1. B&L optical glass, fully annealed, ground and polished to test plates.
2. Fraunhofer-type design, giving superior correction for zonal and comatic aberrations when achromatized for C and F lines for visual work.
3. Spacer hand corrected to remove residual zonal errors.
4. Flanged cell permitting simple, accurate mounting without laborious thread chasing.
5. Cell of brass, precision machined to assure perfect and permanent centering.
6. Retainer ring sealed in place after all adjusting and correcting is done.
7. All surfaces coated with magnesium fluoride in accordance with Navy specifications.
8. Air Space Design eliminates flexures and stresses that occur in cemented objectives due to temperature changes.
9. Cell chemically oxidized to give a dull black non-reflecting surface that is non-scaling.

THE 3" objective is 77 mm in diameter and 1125 mm E.F.L. The 2" objective is 51 mm in diameter and 800 mm E.F.L. Each cell has a serial number engraved on it, corresponding to the objective. Every purchaser will obtain a certification for his objective giving: (1) Glass melt, indices, and dispersions; (2) Test plate mate; (3) Coating inspection; (4) Artificial Star Diffraction pattern test; (5) Measured exact B.F.L. We will have on file a duplicate and, therefore, will have a complete record for every objective we sell.

BECAUSE of tooling costs, we are going to produce the 2" and 3" objectives only. The price for the 2" objective and cell is \$26.50, and the 3" objective and cell, \$53.50 postpaid, in the U.S.A.



BRANDON SCIENTIFIC DEVELOPMENT

A New York Corporation

P. O. Box 85

Malverne, New York

of the visible fluorescent-light phosphors, special black-light phosphors coat its inner surface. A special glass mask blocks out stray visible light that is present even with black-light phosphors. Featuring a five-year life, non-blinking instant starting, and unaffected by frequent turning on and off of the radio, the new Westinghouse lamp has a luminous length of seven inches, an overall length of eight and one-half inches, and a five-eighths inch diameter. Initial starting voltage for the miniature fluorescent lamp is provided by the radio's power transformer

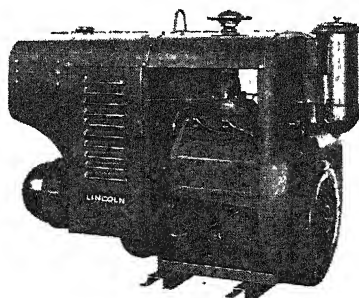
PORTABLE WELDER

Uses Air-Cooled Engine;
Is Light and Compact

FOR WELDING applications in non-electrified areas such as farms, oil and gas fields, construction work, and so on, a new 200-ampere welder known as the "Shield-Arc Jr.," is of exceptionally compact design. Measuring 24 by 48 by 30 inches, and weighing 660 pounds, the welder has a current range of from 40 to 250 amperes. Uses for the machine, as explained by its makers, The Lincoln Electric Company, include welding of light or heavy gage metal, repairs to cast-iron structures such as engine blocks, repair or fabrication of tools and machinery parts, and hard facing of worn parts.

The welder is powered by a Wisconsin air-cooled, four-cylinder engine.

Welding current is controlled by adjusting the engine speed between a maximum of 2100 revolutions per minute—22 horsepower—and 1500 revolutions per minute—16 horsepower. This type of drive not only reduces weight but the air cooling eliminates the necessity of winter radiator care.



Engine speed controls welding current

Equipped with a six gallon capacity gasoline tank, the unit will operate under normal welding conditions for approximately six hours between refuelings.

STEEL WHEELS

Lubricated by
"Floating Ball"

TWO pressed steel disks, permanently joined by a special copper brazing method, form the basic structure of newly available industrial wheels

rugged enough to support loads up to 500 pounds. Tires are vulcanized directly on the wheel which has a "V" groove center line in the rim to assure permanent alignment.

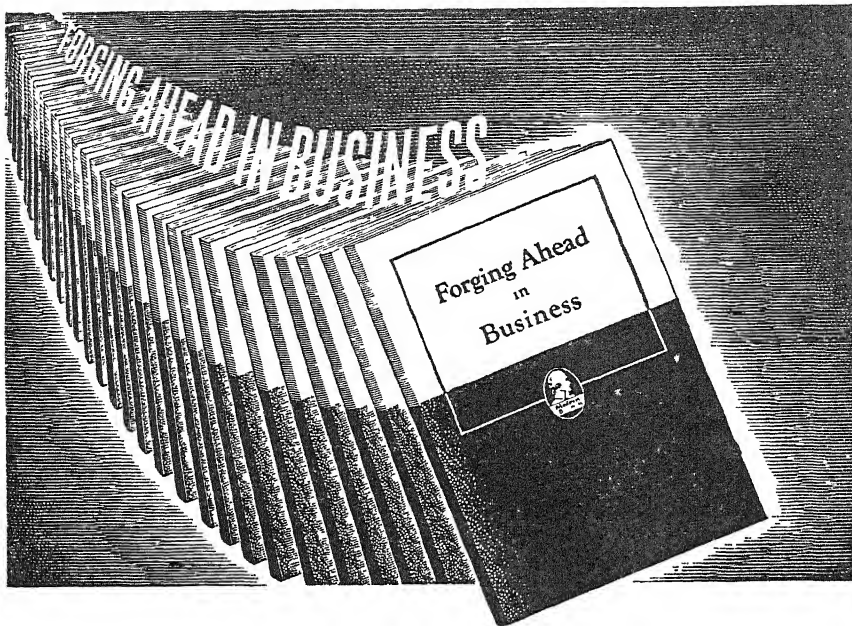
The ¼ inch wall hub is lubricated by the "floating ball" method which consists of placing a steel ball in the oil reservoir before brazing so that the ball action in the lubricant provides automatic lubrication and in addition rattles when the reservoir is dry. The wheels, as described by the American Brazing Company, may be obtained in either six- or eight-inch sizes and with roller or needle bearings.

SYNTHETIC ENAMELS

Produced for Household
Equipment Applications

ALL-SYNTHETIC, high-bake enamels that give an exceptionally hard, stain-proof finish designed to endure heavy household usage have been developed by The Arco Company. These finishes, called Synox, are already being produced in several whites which have been thoroughly tested and adopted by some of the country's largest household appliance manufacturers. One type is designed for refrigerators, deep-freeze units, stoves, ironers, and electric mixers, and another for dishwashers and washing machines.

Tests in the Arco evaluation laboratories and by initial users show that these enamels have an unusual degree



All Serious-Minded Production Men SHOULD HAVE THIS FREE BOOKLET!

FORGING AHEAD IN BUSINESS contains a message of particular importance to production men. This is your opportunity to obtain a copy of this famous book, which has been described as a "turning point in the lives of literally thousands of men!"

Although "Forging Ahead in Business" has been distributed to more than 3,000,000 men, today's timely edition was written in the light of recent world-wide developments. Its 64 pages represent more than three decades of successful experience in training men for leadership in business and industry.

It demonstrates the method which the Alexander Hamilton Institute uses to give you immediate help in your present position, while preparing you for post-war opportunities. Subjects directly related to the work you are doing now, PLUS other subjects of fundamental value to the business executive, are discussed in the book and placed in significant relation to one another. Thus, a helpful, over-all picture is provided.

Said one man who had sent for "Forging Ahead in Business":

"In thirty minutes this little book gave me a clearer picture of my business future than I've ever had before."

... and that represents the opinion of

the Institute's 400,000 subscribers, including 134,000 production men!

The booklet further explains how it is possible to offer this essential training in a minimum of time; how the Institute program fits in with the most crowded of post-war schedules.

Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp.; and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

Send for

"FORGING AHEAD IN BUSINESS" TODAY!

Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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of water and alkali resistance, stain resistance, and exceptional color retention. They resist normal fruit acids, vinegar, and so on, and are not affected by dilute or concentrated alkaline solutions which frequently attack and discolor enamel coatings in common use.

The coating resists the action of hot soapy solutions without dulling or excessive softening or embrittlement and is said to have greater abrasion resistance and lower water retention than other enamels.

SOLID TIRES

Of Neoprene, Aid
Industrial Trucks

INDUSTRIAL solid tires of neoprene type synthetic rubber, which promise to reduce power consumption up to 60 percent as compared with ordinary solid tires of present construction, are now available for use on electric and gasoline powered trucks and manually operated materials-handling equipment. Where minimum rolling resistance is a prime necessity, neoprene industrial tires closely approach the performance of natural rubber, according to United States Rubber Company. This is important in the operation of electric trucks and tractors, and is also an economy factor for gasoline powered vehicles because lower power and fuel consumption, gained through easier starting and rolling, result in reduced per-ton-mile costs. In addition, greater maneuverability, with neoprene tires, makes possible more trips per shift.

GRIPPER-END CHAIN

Grasps Steel Sheet and
Barrels for Carrying

A CAM-LEVER mechanism and chain that grabs up heavily laden steel barrels and steel plate, and holds with a vice-like grip that grows tighter the heavier the load, is announced by The Boyer-Campbell Company. Known as "Granny Grip"—no teeth, but what a



Chain and grips will lift four-ton load

bite!—the standard unit consists of two stamped-alloy steel bodies—cam lever mechanism—and an alloy chain that is capable of lifting up to a four-ton load. The jaws can be opened to $\frac{3}{4}$ inch. Intended to facilitate handling of material with industrial trucks and cranes, the sling-like device may be installed quickly and releases immediately when the load is put down.

HAND POWER TOOL

*With Accessory Kit
is Portable Workshop*

DESIGNED for vibrationless high-speed operation, a new hand power tool has a special finger grip which makes it easy to control for close delicate work. An on-off switch allows one-hand operation.

Equipped with 35 interchangeable parts, this new electric hand power tool is intended as a versatile utility instrument. Included in the tool-kit are a grinder, emery wheel, polishing buffer, and sharpener. Other tools may be attached for jobs requiring roughing.



Versatile, complete kit has 35 parts

sawing, drilling, routing, and etching. Suggested uses are for making tool parts, repairing electric motors, cutting wood patterns from stock, and similar work. Various brushes are also handy for cleaning motor parts and getting into small crevices and hard-to-reach spots. The all-purpose tool has equipment designed especially for working on metal, plastics, glass, and wood.

Operating at over 20,000 revolutions per minute, on either A.C. or D.C., overheating and like problems are said to be offset by an air-cooling fan, oil-less bearings, and positive insulation. A ball thrust end bearing helps to absorb shocks; the case is also shockproof.

As a safety factor, the makers, Casco Products Corporation, have incorporated a safety clutch for locking the chuck to prevent slipping when tool parts are changed by the worker.

The tool and accessories are stored in a steel chest, $13\frac{1}{2}$ inches long, 6 inches wide, and $4\frac{1}{2}$ inches high.

EMERGENCY RESPIRATOR

*Provides Oxygen When User
Breathes through Canister*

EMPLOYING a replaceable chemical canister, a recently developed breathing apparatus generates its own oxygen and gives the wearer one hour's pro-

Ingenious New Technical Methods

*To Help You with Your
Reconversion Problems*



Drillet Box Jig Saves Up to 75% of Jig Body Expense and Labor!

The six-sided Drillet Box Jig above and at right has a range of 125 different sizes, making it possible to accommodate all sizes up to 6" capacity—for drilling, reaming, counter boring, counter sinking, spot facing, tapping, etc.

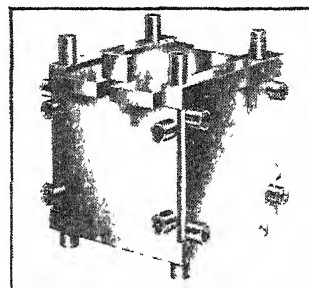
The Drillet Box Jig makes special tool design for drill jig unnecessary. Saves up to 75% of the time and cost of building a jig body. By merely turning thumb-screws and raising leaf, parts may be quickly loaded or unloaded. The jig may be used on all six sides, taking advantage of its full capacity.

Another useful product is chewing gum. You can enjoy chewing Wrigley's Spearmint Gum even while your hands are busy. The pleasant chewing helps to steady you—helps keep you alert and on your toes when you're doing a monotonous job.

Besides the satisfaction chewing gives you, it helps keep your mouth moist and fresh so you naturally feel better—and feeling better you work better.

Scores of industrial plants report that they have stepped up their workers' morale and efficiency by making chewing gum available to them.

You can get complete information from The Chicago Drillet Corporation, 920 S. Michigan Ave., Chicago 5, Ill.



Drillet Box Jig in Locked Position



AA-59

tection in unbreathable air. Weighing $13\frac{1}{2}$ pounds, and with no cylinders, high-pressure valves, or fittings, the Chemox Oxygen Breathing Apparatus appears well suited to the requirements of industry and fire departments in meeting emergencies where high concentrations of poisonous gas or oxygen deficiencies are encountered. The mask was proved in Navy battle service during the war, according to its developer, the Mine Safety Appliances Company. In operation, exhaled breath passes from the facepiece, through the exhalation tube, and into the canister where carbon dioxide is removed. Evolved oxygen flows into the breathing bag reservoir, then to the facepiece through the inhalation tube.

Quickly put on and simple to use,

the apparatus has a pre-set alarm bell which rings a warning before the canister is exhausted.

PRODUCTION GRINDER

*Features Versatility and
Adaptability to Difficult Grinds*

A NEW design of multi-purpose grinder has the wheel-head mounted on two different compounds, each graduated to 180 degrees. This is reported by the manufacturer, Lempco Products, Inc., to permit even the most difficult of internal or external taper grinds or turns to be easily and accurately done. The grinder has a workhead that can be moved 6 inches toward or away from work by removing and replacing four screws. This ad-

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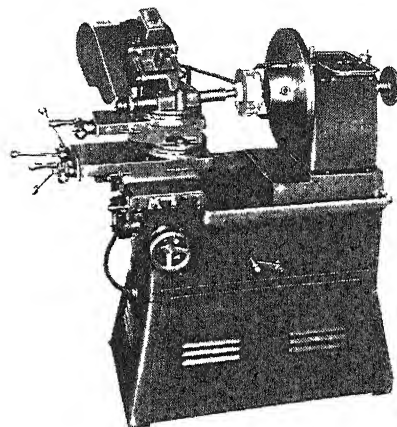
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URANIUM AND ATOMIC POWER — By *Jack Dement and H. C. Dake.* Somewhat technical treatment of the underlying principles and theories of the work. Includes a valuable bibliography. **\$4.10**

justment increases the swing from 18 to 30 inches. Other features include both hand and power cross-feeds, a work length capacity up to eight inches, and two reversible spindle speeds of 80 and 130 revolutions per minute. Chucks are draw-bar mounted.

Wheel-head power is supplied by a two horsepower motor with ball-bearing spindle, and speeds range from 6000 to 12,000 revolutions per minute. A retractable tool holder bar enables finished grinding to follow turning operations without removing the cutter. Power cross-feed length can be set by



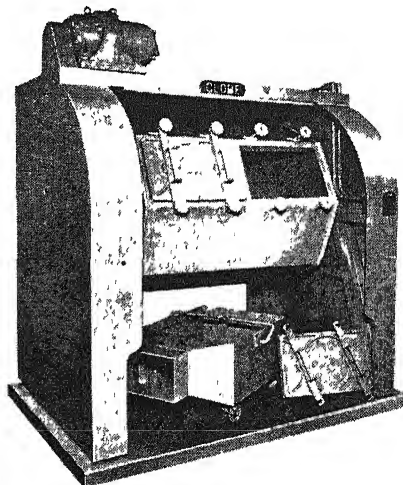
Cutter retractable for finish grinding

dogs on the side of the carriage, while longitudinal feed is controlled by an interchangeable screw or rack and pinion. An automatic sizing device is said to insure exact duplication of successive pieces on production runs.

DE-BURRING UNIT

Polishes and De-burrs
Simultaneously

PROVIDING mass-production de-burring, and claimed to increase output by as much as 21 times over hand labor, a new "Burr-Rite" machine features double and triple compartments which can perform two operations—polishing and de-burring—simultaneously. Manufactured by The Globe Stamping Division, Hupp Motor Car Corporation, the



Two compartment unit; hoist pan below

(The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.)

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new device finishes aluminum, brass and die castings. Parts handling has been simplified by the installation of a new hoist pan.

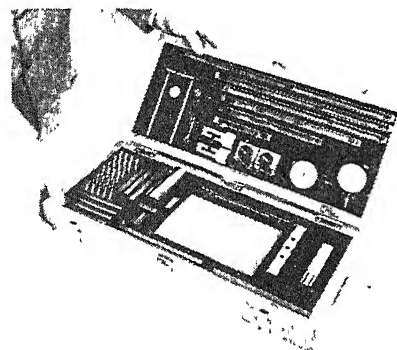
Three models are offered: a single compartment model with a cubical content of 184 feet, a double compartment model, with a capacity of 9 cubic feet in each compartment; and a triple compartment model, in which each compartment has a 51 cubic feet capacity

PRECISION KIT

Allows "Large Shop" Gaging at "Small Shop" Cost

A NEW GAGE kit, called "Producto-Chek," and designed for production checking, is now being manufactured by the Gage Division of The DoALL Company. It consists of a number of instruments to be used in conjunction with gage blocks for quickly setting up practically any type of inspection gage. Examples of these combinations are a dial-indicating snap gage, plain bench comparator, dual bench comparator, angle comparator, square comparator, precision height gage, depth gages, and a series of go-no-go snap gages of any size up to 18 inches

Plug gages and internal gages of any size, in steps of .0001 inches, can be

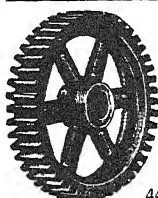


Kit has over a million combinations

quickly made up from the set. In addition, gages such as hole-to-hole, hole-to-base, parallel-bore, pitch diameter, and many others can be made up for special applications. A set of holders from two to 18 inches in length are designed to carry the gage blocks. Besides the hand-held gages, a series of bench and surface plate gages can be assembled by using the base block, master flat, or other attachments. In addition to the usual types of gages, there are several unusual ones such as an indicating snap gage incorporating a dial indicator, and an internal gage incorporating a dial indicator.

Also included in the kit is a set of "wires" of various diameters. These are lapped to the accuracy of gage blocks and are used direct as plug gages or in caliper jaws where square jaws could not function or where combination square and round caliper jaws are needed. Although it is used in conjunction with gage blocks and in some cases a surface plate, the kit itself does not include these items. Any one of the many gages can be assembled in five minutes or less. It is reported that the

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Elapsed Time Counter . \$7.50
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One ampere Mercury Switch, 10" long leads . 35c 3 for \$1.00
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Here is an example of "DIE-LESS DUPLICATING" typical of a great variety of formed parts readily made with DI-ACRO Precision Machines — Benders, Brakes, Shears. Picture shows the finished part formed to die precision, including acute right angle bend. Women operating DI-ACRO UNITS maintain a high out-put on production work.



Pronounced "DIE-ACK-RO"

O'NEIL-IRWIN MFG. CO.

4,000 Parts Per Day with DI-ACRO Bender

"Enclosed is picture taken in our plant which proves the DI-ACRO Bender will do a real production job. We are making 4,000 completed parts per day, which is competitive to most Power Presses." (Name on request).



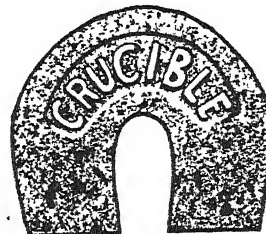
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MINNEAPOLIS 15, MINN.

LITTLE GIANT HORSESHOE

4 OUNCE "ALNICO" MAGNET

100



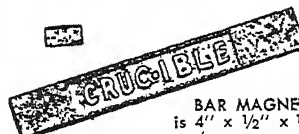
Lifts 20 times own weight



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"ALNICO"
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is 4" x 1/2" x 1/4"
4 oz per pair

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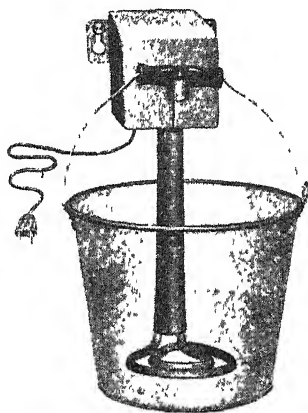
Producto-Chek Gage Kit will actually do the work of more than a million separate gages, but it weighs only 40 pounds and is housed in a hardwood box 10 by 20 by 4 inches.

Particularly adapted to the small shop, the kit has the advantage of limitless precision measuring equipment at the cost of barely a dozen separate gages. Thus it enables engaging in all kinds of precision production work not previously advisable because of the high investment in many separate instruments for proper inspection

WATER HEATER

Conveniently Heats a
Bucketful at a Time

A SHOCK-PROOF electric water heater weighing about ten pounds and designed for use in an ordinary bucket consists of a switch in a compact sealed metal box with the heater coil suspended beneath it. On the side of the box is a switch lever which also acts as a support for the pail handle, automatically turning on the current when a pail is hung on it. Should the water



Hot water when and where needed

boil away below a certain level, the switch automatically cuts off. The device can be suspended from a wall by slotted holes placed near any convenient electric outlet. The heater has many uses around a shop, factory, or farm.

CARPETS CLEANED

Conveniently "On the Spot"
With Soapless Detergent

LOCATION cleaning of wall-to-wall carpeting in hotels, clubs, theaters, restaurants, and other places where removal of floor coverings is inconvenient, is an advantage offered by a new detergent, with high lathering properties, that is said to contain no soap. Used in solution and applied by means of a rotary brush, released dirt and soiled detergent are removed with a wet vacuum. The cleanser, called Neutrotone, removes ordinary types of soil, disinfects, deodorizes, and demoths, without leaving a residue or harming texture, color, or tensile strength, according to its manufacturer, The Mathieson Alkali Works.

Although designed for on-location

cleaning, carpet cleaning plants may also find it useful where shrinkage of the floor covering or untwisting of twisted pile carpeting might be caused by the regular plant shampooing process

PAD DYEING

Done with Water-Resins,
Requires no Solvents

OIL-IN-WATER pigment resin finishes, for the pad-dyeing of fabrics, are now available to the textile industry. The water-thinned emulsions require no expensive and inflammable solvent thinners. Extenders and high-speed mixers are also unnecessary, and it is claimed that the problems of color exhaustion and migration are eliminated. The new Sherdye "Water-Thinned Pigment-Resin" colors, manufactured by Sherwin-Williams Company, promise possibilities of substantial cost saving, and it is said that there is less time lost in preparing for a run or in changing colors between runs. Equipment is cleaned simply by washing down with water between operations.

DISTRESS SIGNAL

With Day or Night Colors
Is Highly Visible

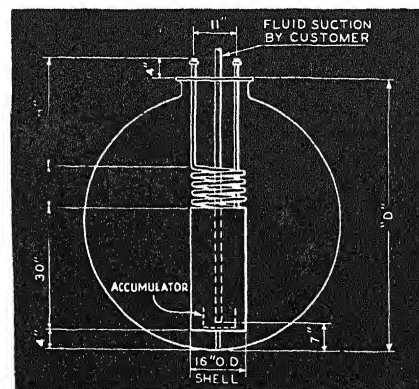
GIVING off a brilliant orange smoke for day-time use and a blindingly intense red flare at night, a double-ended, compact hand-held pyrotechnic signal is now offered for civilian users.

In use, the desired fuse is ignited by breaking the seal and pulling an igniter ring. Special construction prevents burns and allows the signal to be doused in water, after one signal color has been discharged, without damaging the signal color in the opposite end. Burning time is 18 to 20 seconds, according to Aerial Products, Inc., and both the day and night color charges are contained in one unit 5½ inches long and 1½ inches in diameter. The signal is expected to receive wide reception with commercial and private marine operators, sportsmen, and flyers.

TANK PRE-HEATER

Warms Heavy Liquids
Stored in Bulk Tanks

LOWER grade oils, tar, asphalt, and other heavy bodied liquids requiring pre-heating for proper combustion or



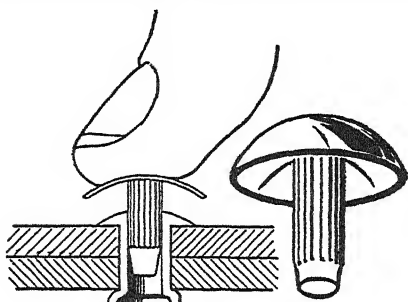
Pre-heater for heavy liquids

handling can be warmed before leaving the bulk tank, with a new pre-heater incorporating 38 square feet of direct radiation surface. Built for use with either steam or hot water, the pre-heater, developed by the Rempe Company, is provided with a flow accumulator which assures that the liquid will flow over the coils before entering the suction line. The unit fits any size tank having a man-hole of 16½ inches, or larger, diameter.

RIVET PLUG

To Be Used With
Hollow Rivets

USERS of hollow Cherry Rivets who find it desirable to have the head of the rivet match or harmonize with the surface color or texture of the material being fastened, will now be able to use newly developed Umbrella Plugs which fit into the center of the rivets. The head of the plug furnishes a smooth cap completely covering the head of the rivet. These plugs, available in aluminum, copper, or plastics, can be colored to match or harmonize with the



Plug presses into place

surrounding surface. Typical application examples are enameled signs, furniture, smooth surface household appliances, and industrial equipment.

Easy to insert, the plugs have a knurled and tapered shank which fits tightly into the hollow center of the rivet. The pointed end of the shank is inserted into the installed rivet, and the plug is pushed in by hand.

DEEP DRAWING

Facilitated by Stable
Chemical Compound

A DRAWING compound that maintains its inherent physical properties during repeated deep drawing of ferrous and non-ferrous alloys has a high film strength and does not separate even under intense stresses. The properties of the molecules at the interface, between the lubricant and the metal surfaces, remain constant during the drawing operation because of the chemical stability of the compound.

Superdraw, as the compound is called, is unaffected by atmosphere and heat, its complex organic molecules resisting chemical and physical deterioration. Chemically inert, it leaves no heavy scale nor does it leave stains on the surface of any alloy. Superdraw is easy to apply—by hand, brush, spray, roller, dipping, or pouring—and it may

be extended to suit the draw by diluting with warm water. It is easily removed with any alkaline cleaner or any routine cleaning procedure.

AIR CONTROL

Valve Operated by
Simple Foot Pedal

DEVELOPED to meet a demand for an air control low in cost but constructed along the same lines as the higher priced controls, the new Redmer foot control has a brass valve which will withstand plenty of abuse.

The foot pedal is designed so as to make its operation as tireless as pos-



A roller makes action easy

sible. The opening and closing of the plunger of the valve on the foot pedal is operated by a roller on the pedal casting which relieves wear on the plunger and facilitates its operation.

SOFT SLEDGES

Have Replaceable
Striking Surfaces

SOFT hammers, in the light-sledge weight range, are now available in two new models. One has a replaceable copper or brass head; the other replaceable brass or copper tips. Each type comes in four head diameter sizes: 1¼, 2, 2½, and 2½ inches, and weigh from 4½ to 10½ pounds. Equipped with safety leather washer handles, these Perfect Balance soft hammers have been designed for use in locomotive shops, for the assembly of heavy machinery in tool and die shops, and so on. The steel head on the removable-tips model is case hardened.

Made by the Gregory Tool and Manufacturing Company, the complete line of these hammers now consists of 12 different models and 56 different numbers, ranging in diameter of head from ¾ to 2½ inches, and in weight from 3½ ounces to 10½ pounds.

INTERNAL PLATING

Makes Steel Piping
Corrosion Resistant

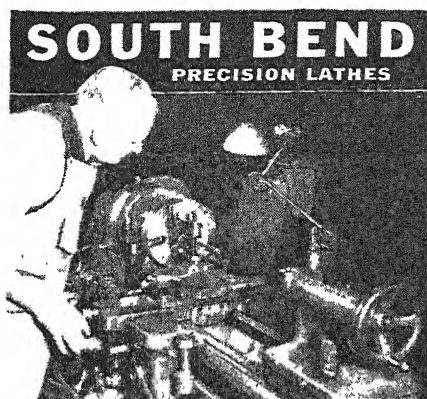
A SMOOTH, ductile, pore-free nickel deposit, fully adherent to the base metal, can now be applied by electroplating to pipe or tubing up to 18 inches overall diameter, in random lengths of approximately 20 feet. The process endows steel pipe with the corrosion-resistance of nickel, while retaining the low cost, strength, and fabricating characteristics of the steel. Internally plated pipe can be welded, reduced, and bent—hot or cold—without destroying any portion of the internal lining, according to the proc-

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by George W. Pearce

The author, a mechanical engineer, re-views the history of housing and shows how building costs have risen in the last 150 years until few families can buy a house adequate for their needs.

He then describes how, by the use of various money-saving building methods, a large, modern, 6-room, thoroughly insulated, fire resistant, 2-bath bungalow with garage can be had most anywhere in the United States for \$2800.00

Included with the book are 10 folded drawings 12" wide x 18" long. These drawings by Mr. Pearce show all the details of construction for this house — the wiring, the plumbing, the automatic oil heating system and the fluorescent lighting. The book is devoted to showing how similar savings can be made on any house of any style, size or floor plan.

A very readable and interesting book. Every prospective home owner should have a copy. 138 6" by 9" pages, 26 illustrations, leatherette bound, 10 large drawings. Send \$2.00 to TECHNICAL PRESS, Box 61, Swampscott, Mass. and your copy will be rushed to you postpaid. Distributed solely by Technical Press — Not sold in book stores.

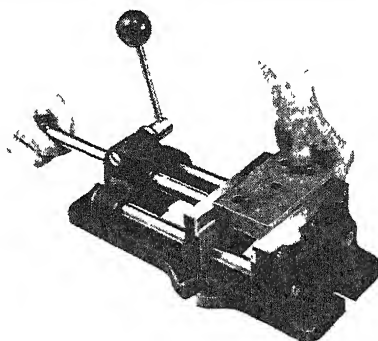
essors. Bart Manufacturing Company Lectro-Clad piping is said to make substantial savings possible and to extend the use of corrosion-resistant material to applications formerly prohibited by the high cost of solid alloy pipe

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Instead of Screw

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Locked by a lever

cision ground. The wide clearance between jaw guides permits drilling right through the work and prevents interference from accumulating chips. Jaws have built-in, recessed parallels. A removable V-jaw accessory accommodates round pieces.

METAL ROOFING

Protected by Treatment
With Adherent Compound

PROTECTED metal for roofing and siding on industrial and agricultural buildings is available in the form of flat, corrugated, or V-crimp steel sheets, the surfaces and edges of which have been treated with "Plastipitch," a compound perfected by Koppers Company, Inc. The compound adheres permanently to metal at low as well as high atmospheric temperatures and thoroughly protects the base from rusting, corrosion, salt air, and the effects of chemical fumes present in many areas.

Besides uses for roofing and siding, the material is suitable for gutters, ventilators, flashings, ducts, and so on. The sheets can be easily fabricated without special equipment and can be bent without impairing the coating because of its toughness and elasticity. They do not require further painting.

CONTAINER COATING

Covers in One Application;
Resists Heat and Food Acids

INCREASED production and better decorating results appear to be in the making for the metal package industry

with the introduction of Rolox vinyl white coating enamel.

Said to fill the need for a one-coat material with good resistance to food acids and fats, and to provide stability under high and repeated baking temperatures, Rolox vinyl white offers an improved sanitary lining coating for use on foodstuff containers requiring pasteurization, sterilization, and processing.

An unusually high solids content, heretofore difficult to obtain in vinyl coatings, contributes to the superior properties of this new flexible coating. This increased pigment is reported to give hiding power equal to that of two coats of conventional vinyl materials, while the greater vehicle content is responsible for the high gloss and tough, mar-resistant film surface, as well as better flowing qualities that help eliminate ridging.

The material may be applied directly to unsized black plate, electrolytic or hot dip tin, and is odorless and tasteless, the latter features being of importance in food and cosmetic packaging.

MICROFILM RECORDER

Photographs, Endorses, and
Face-Stamped Checks and Papers

FOR USE in banks and offices, a new microfilming machine simultaneously photographs the front and back of a business document. The document's area is reduced by 1000 times and the images appear side by side on a narrow 16 millimeter film.

Known as the Duplex Recordak, produced by Eastman Kodak Company, the new machine employs mirrors so that the front and back of a piece of paper are reflected simultaneously to the camera.

One hundred bank checks or reference cards, both sides, can be reproduced on one foot of 16 millimeter microfilm, or more than eight images per inch. On a 100-foot roll, more than 10,000 checks—front and back—can be photographed. A duplicate film can be exposed at the same time, since the



All the mechanism of the Recordak is contained in a desk-size cabinet

film unit has two lenses and holds two rolls of film.

The new machine will also endorse bank checks. Placing an endorser mechanism inside the microfilming machine is expected to save considerable time and work in banking procedures, by eliminating a separate operation.

A third job performed by the machine is face-stamping each document. "Photo by Recordak" is printed on each document before it is recorded. Thus bank checks or business papers which might become involved in legal proceedings are known to be "filed" on microfilm.

CONCRETE FORMS

*Protected by New
Surface Film*

CONTRACTORS can now coat the surface of plywood concrete forms with the same thickness of protective film in one coat as was previously obtained in two coats. The additional protection and the saving in application and handling will be particularly welcome on large concrete jobs.

The new A. C. Horn Company Form-film is used for preparing forms, such as plywood or other fibrous wood, in which concrete will be held in proper position until setting has taken place. The proper coating of plywood with Formfilm produces smooth concrete, free from grain markings and ready for painting if desired.

The film is said to condition the plywood so that it is highly resistant to warping or swelling because the Form-film is highly water repellent. No concrete will adhere at any stage of setting. Tests have indicated that re-use of coated plywood forms as often as four or five times without recoating is possible, and that the life of the plywood is materially increased.

TELL-TALE LABEL

*Warns of Dampness
by Turning Pink*

SENSITIZED labels—smaller than a postage stamp—which change color with humidity are now available to serve as humidity indicators in a multitude of applications. Color changes are distinct, definite, and reversible; the label being a brilliant blue-green when dry, and pink when humidity approaches the point where mold, mildew, corrosion, rust, soggy, and so on occur.

"Hygro-labels" are self-adhering and are supplied in roll and strip form upon a protective backing. Individual labels may be placed on, in, or between the material to be checked. By removing the label from the protective backing it may be affixed to any surface. Leaving the protective backing in place allows the label to be placed in any powdered, granulated, or flaked material without contaminating the product.

Some of the suitable applications appear to be: checking the degree of moisture in rooms, containers, tanks, and like places; determining the moisture content of powder, cereal, cotton,

cloth, paper, tobacco, and so on; and testing the leak-proofness of glass, cellophane, waxed, or other sealed packages. Labels may be used repeatedly.

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*Withstands Temperature
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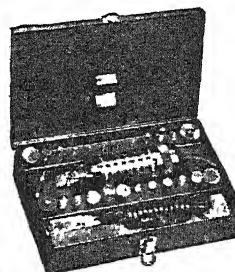
available with a sealed-in snap-action switch that has an electrical capacity of six amperes at 64 volts DC and 10 amperes at 110 volts AC. The pressure adjustment can be securely locked and sealed. Direct wire connections to terminals through a grommet opening eliminate wire splicing.

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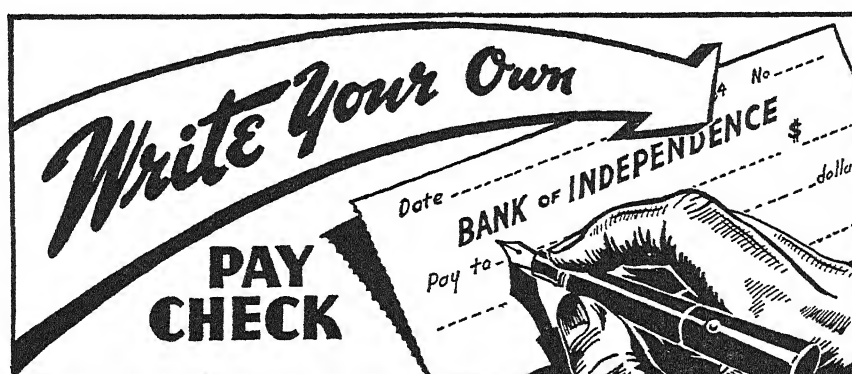
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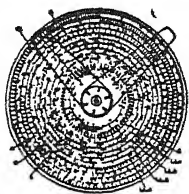
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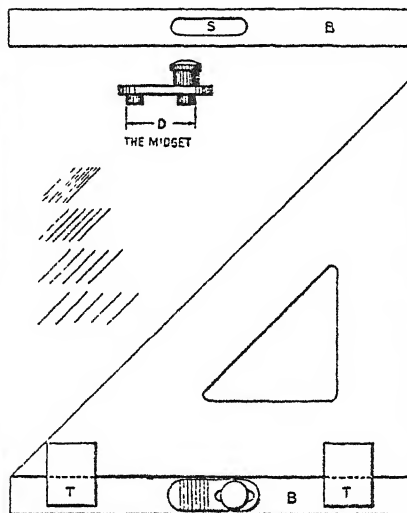
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control extremes of pressure, while the large diaphragm area is described as giving close differentials. Normally-off or normally-on adjustments are a matter of changing one wire. Pressures ranging up to 150 pounds per square inch are suitable for operating the unit. All parts of the Nason "Pressure-Clix" switch are rust-proofed.

DRAFTING SPACER

Puts Cross-Shading Lines
on Mechanical Basis

CROSS-HATCHING and shading are reported to be simplified and improved in spacing by a new lateral-spacing bar that attaches to a standard draftsman's triangle. Known as the "Midget" bar, the device may be adjusted to



Draftsman aid is attached to an ordinary triangle by strips of tape

any desired spacing up to about 3/16 inch. Attachment to the triangle is accomplished with a tape, although special slotted triangles are also available for use with the bar.

CELLULOSE TEXTILE FINISH

Made of Wastes by
Oxidizing Method

SUBSTITUTION of an oxidizing agent for heat is now reported to provide an improved method of making cellulose suitable for textile finishing. In the past, heat has been difficult to control in the exact amounts required, and local over-heating sometimes created non-uniformities in the finished product.

In the new process, cellulose is treated with an oxidizing agent for sufficient time to increase its solubility in aqueous-alkaline solutions. Waste-regenerated cellulose is the preferred material to use in making this finishing agent, according to Sylvania Industrial Corporation, developers of the method.

Inexpensive raw materials, and ease of controlling the manufacturing process, appear to indicate a large potential use for the product in the textile finishing field. It may also be used as a pigment binder in the printing and pad dyeing of textiles.

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CATALOG NUMBER 45 compiles pertinent information on safety and relief valves. Line drawings depict basic types, with charts showing what each type can be used for. A condensed bulletin and price sheet are contained in a supplement (Number 45A) to this catalog. *Farris Engineering Company, 400 Commercial Avenue, Palisades Park, New Jersey—Gratis.*

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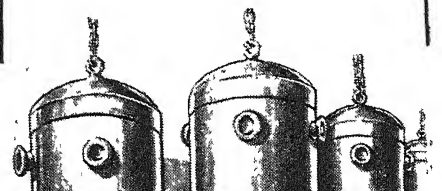
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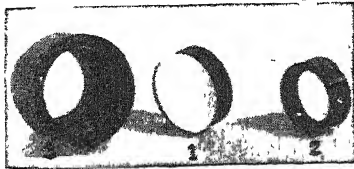
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FOR OBSERVING faint objects, such as nebulae and the Milky Way stars, telescopes of short focal ratio are the best suited; they concentrate the light gathered by the objective lens on a small area, well illuminated. On the other hand, for observing planets, where there is plenty of illumination, high magnification is possible and this may be had by use of telescopes of long focal ratio which have a large image, sufficiently well illuminated. Most ordinary telescopes are a compromise, and serve fairly well for both purposes.

The telescope described below has very long focal ratio (1:30) and is specialized on planetary purposes. Its tube is nearly nine feet long, though its aperture is only $3\frac{1}{2}$ inches. It was designed and built and the specifications for its objective lens are given below by Lieut.-Colonel Troy W. Lewis, an amateur telescope maker who both designs and constructs, and who lives at 1812 Schiller Ave., Little Rock, Arkansas.

Of course, in optics, whenever you gain some advantage you must pay for it with some kind of compromise (lucky if only one) and thus this refractor frankly abandons the advantage of compactness. It is true that the

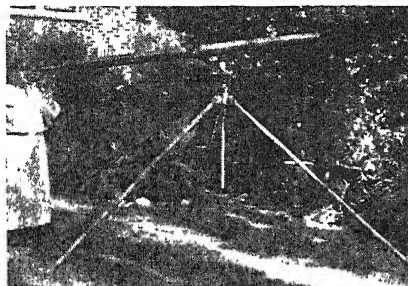


Figure 1: Lewis long-focus refractor

Cassegrainian type of telescope enjoys both long focus and compactness but it does not enjoy the same simplicity of construction as the Lewis refractor. Perhaps the following article, with the one on long-focus reflectors in the February number, will help start a new trend in the long-focus direction. Colonel Lewis writes:

THIS COMMUNICATION deals with several advantages found in designing, constructing, and using an achromatic refractor with focal ratio double that of the usual $f/15$.

Splendid pioneer work was done by astronomers some generations ago who used, through necessity, long-focus plano-convex single lenses made from inferior window or bottle glass. Perhaps some of the best work done by

those pioneers was with telescopes from 12' to 33' long, with apertures between 2" and 3". Inherent spherical and chromatic aberrations were rendered less obtrusive through the application of the well-known laws of diminishing curvature and the concealing of color errors into the image by diffraction. A maximum correction of aberrations under these laws occurred when the focal length approached 100 times the square of the aperture of the objective.

There were some monstrosities in telescopes in those days. Thus, the Huygens brothers made objectives up to 210' in length, with a 6" aperture, but their best work was done with a 23' telescope of $2\frac{1}{3}$ " aperture. It was with this glass, power 100, that Christian Huygens solved the great Saturnian mystery in 1659.

The achromat, invented by Chester More Hall in 1733, for many quite obvious reasons displaced the older long-focus single lenses in frail tubes or more unstable girders, but it could not wholly destroy the merits of properly designed long-focal-ratio lenses. Professor David P. Todd, as late as 1911, strongly recommended the construction of a long-focus open-air telescope in a steel box-girder, reinforced so as to be unyielding and rigid, thus to secure the many advantages of long-focus lenses under modern conditions.

Most astronomers agree that the visual refractor is ideal in the study of fine detail in planetary images, but for critical work in selenography, saturnigraphy, or in areography, it must be admitted that the focal ratio of the objective should be very much higher than the standard type $f/15$ established by Fraunhofer many years ago.

The amateur astronomer who wants a modern long-focus telescope for planetographic work will usually have to make one to his own specifications, for such telescopes are rated by professional opticians as exceptional and expensive. A special lens design is called for and that, in itself, is no small item of expense.

Such special lens designing is, however, possible. An achromat for any desirable focal length may be achromatized for any two bands of the visual spectrum at the designer's option, such as B and F, C and F, D and E, D and F, or, for photography, D and G'; and where the amateur makes his own objective an effort should be made to achromatize for his particular vision if he is allergic to either red or blue. Vision differs widely with individuals.

It had long been the desire of the writer to design and construct a mod-

ern 23' achromatic objective of 4" aperture, and a glass of that size was under actual construction when the war called him to active duty with the armed forces, thus suspending further activities in the optical field for the duration and six months. Fortunately, two smaller long-focus telescopes had been made, in 1939, as stepping stones to the ultimate $f/69$. One of those, Figures 1 and 2, is here described.

This $3\frac{1}{2}$ " achromatic plano-convex objective, $f/30$, was made from optical glass readily obtainable on the American market. It is shown (Figure 1) in its first temporary altazimuth mount. Should the amateur wish to make this telescope for his own use let him do so with complete confidence. He will find, provided his vision is entirely normal, that the objective has many of the characteristics of an apochromat. Such trying objects as Venus will be seen

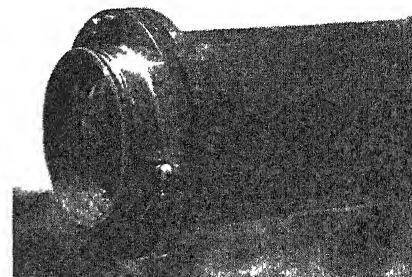


Figure 2: The brass push-pull cell

without noticeable secondary spectrum—bright and colorless. Fine details on the Moon are remarkably clear and distinct. It will resolve to the full theoretical Dawes' limit and, as an enthusiastic friend has commented, "a leetle more!" Its performance really has to be experienced to be fully appreciated.

This lens is a thin plano-convex achromat, cemented, of $3\frac{1}{2}$ " aperture and 105" equivalent focal length. It was designed from Bausch & Lomb glass, Crown, BSC-2; Flint, DBF-1. It was achromatized for the C and F lines. The following is a first approximation design:

Let f = focal length of the crown glass
 f' = focal length of the flint glass

Then $1/f + 1/f' = -1/105$

(1) For the crown glass:

Mean refractive index,

$$\mu = (1.51461 + 1.52262)/2 = 1.51861$$

Dispersive power,

$$= (1.52262 - 1.51461)/0.51861 = 0.01544$$

(2) For the flint glass:

Mean refractive index,

$$\mu = (1.61242 + 1.62843)/2 = 1.62042$$

Dispersive power,

$$= (1.62842 - 1.61242)/0.62042 = 0.02585$$

Then, from the algebraic formula for achromatization, it is seen that $0.01544/f + 0.02585/f' = 0$. The linear spectrum formed along the axis will be folded on itself, bringing the red and blue rays into coincidence.

The design was achromatized to bring the minimum focal point to the brightest portion of the spectrum as viewed by the designer's eye, leaving any outstanding blue and red rays equally pushed away from the axis

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where they can do no harm, since in an objective of this focal ratio both spherical and chromatic aberrations, chromatic residuals, if any, would focus both absolutely and relatively beyond the image plane, as was first observed in ancient long-focus single lenses.

To determine what must be the focal length of each of the two lenses Let $1/f = -2585/1544 \times 1/f'$, Then, $(-2585/1544 + 1) \times 1/f' = -1/105$ Therefore, $f' = 70.79310$ ". Also $f = -1544/2585 \times 70.79310 = -42.28841$ ".

Since one of the surfaces of the flint lens composing this achromat is to be plane, the radius of curvature of the other surface will be identified as R, then, $1/f' = (\mu' - 1)/R$, therefore, $R = (\mu' - 1) \times f' = 43.92145$ ".

The intention being to cement this objective with Canada balsam it follows that the crown lens also must have one radius of curvature coincident with the divergent lens, $R = 43.92145$ ". Let the free surface of the convergent lens, therefore, have a radius of curvature denoted by r.

Then $1/f = (\mu - 1)(1/r - 1/R)$ and $1/r = 1/(\mu - 1) + 1/R = -1/(51861 \times 42.28841) + 1/43.92145 = -232396$. Therefore, $r = -43.03$ ".

This completes the first approximation design Specifications follow

Crown lens 1st surface — 43.03"
2nd surface + 43.92"
Flint lens 3rd surface + 43.92"
4th surface ∞ flat
Crown focus 42.28"
Flint focus 70.78" Combined focus = 105"

To afford full benefit of light traps or stops this objective should be mounted in 4" or 4 1/2" I.D. steel or brass tube and to obtain necessary stiffness this tubing should have at least 1/4" wall thickness. The objective should be housed in a heavy brass push-pull cell (Figure 2) for squaring on. Haviland's remarks on tube structure, page 215, "A.T.M.A.", should be read and his advice followed when calculating the size of the holes in the diaphragms and eye tube. At least six stops should be used; eight would be better. The Moon's image in this telescope is approximately 1" in diameter and very bright.

A battery of at least five Huygenian eyepieces is recommended. These should be a 3", 1.5" and 1" for low power and a 5" and .25" for high power. The 3" and 1.5" eyepieces should be especially made to avoid stopping off part of the light. The 1/4" eyepiece will give 420 diameters for resolving fine detail during moments of fine seeing.

There are several ways of designing a long-focus objective from this or other selected glass.

Thus, the Littrow type (cemented) may make a fair to middling objective with Chance Brothers 1.5115/60 8 Crown and 1.620/36 Flint, all radii of curves to be 42.00" except 4, which will be nearly plane. The Haviland first approximation formula (and it is a good one) indicates $R_1, R_2, R_3, 44.40$ " and $R_4, 671.72$ " convex (cemented) when using 1.516/63.5 Crown and 1.604/37.5 Flint to be had from Leo D. Keller, 2438 N. 19th St., Philadelphia, in 60 mm pressed lens blanks (see "A.T.M.A.", p. 226).

Incidentally, a Fraunhofer type long-focus objective, with small air space between lenses, may be made from B & L BSC-2 and DF-2 with this set of curves $R_1, +63.87; R_2, -37.21, R_3, -37.59; R_4, -155.82$. The writer much prefers the cemented crossed crown lens for his long-focus objective because of its beautiful flatness and wide field. The crossed crown is not, however, the 2 3 structure mentioned in "A.T.M.", p. 110, by Reverend Ellison.

With the explicit information on first approximation design given in the above notes the amateur should be able to design his own objective for any part of the spectrum as he may choose if C and F be deemed undesirable.

Since Hastings has shown ("A.T.M.", p. 179), that it is no more difficult to make a flat for rays normal to the surface than to make a true curve, and since Driscoll has shown (Scientific American, March-April, 1945) how easy it is to grind, polish, test and figure a set of curves, it is believed that the amateur will no longer hesitate to indulge in making for himself a highly desirable long-focus plano-convex refractor for planetary work. Here is how, and luck to all who try.

ANY READER who undertakes the type of telescope described above is urged to keep in touch with Colonel Lewis or with this department or both, though reports to either one are likely to be seen by the other since this department keeps in direct-mail touch with numerous readers everywhere.

It has happened numerous times that the maker of some unusual piece of optics has omitted to write in and crow about it, either from modesty or from the supposition that editors are fed up and probably wouldn't care. It is true that the lower orders of animals lay their eggs and thereafter forget their progeny but the higher mammals, including editors (provided you do), maintain post-partum and post-parental interest. Of course, this department isn't the actual papa of the things it publicizes but it enjoys playing uncle, so crow.

STELLAFANE convention of 1946, Saturday August third, Sunday August fourth! This promises to be a mammoth meeting. Begin planning now. Porter is coming East—"going to Stellafane in August, shake hands on it," he writes. John W. Lovely, 27 Pearl St., Springfield, Vermont, secretary of the Springfield Telescope Makers, is the man to write to if you have any problems connected with the meeting.

Stellafane's first convention was held in 1926. Conventions were thereafter held annually up to and including 1941, that being the 17th of the series. Four conventions, those of '42, '43, '44, and '45, were skipped because Springfield was too war-busy to entertain (it's more work than some of us may realize). During those four years many amateurs, with tones of fear and regret, have inquired whether these classics were ended forever. They were valued.

Scientific American

Founded 1845

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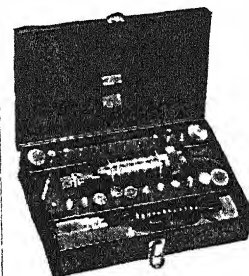
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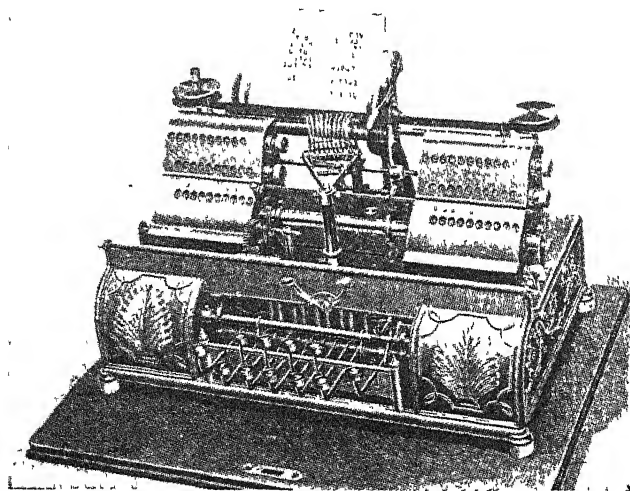
50 Years Ago in . . .



(Condensed from Issues of May, 1896)

MATCH-MAKING — "Five years ago the science of converting logs into matches was said to be a finished science, incapable of further improvement, but American ingenuity has shown that what was 'perfect work' in 1891 will not answer for 1896. Even now the machines used in making matches, wonderful though they are, are not to be left unchallenged, as inventors are working on new ones, whose capacity will, they claim, far excel that of the best machines now in operation."

ADDING MACHINE — "The accompanying illustration presents a machine intended to cover a substantially new field in typewriting and adding machines. . . The object of the invention is to quickly and accurately add a column or columns of figures and, at the same time and by the same manipulation of the keys, to print upon a sheet of paper or a blank book these figures in the order in which they are added, so as to form a proof sheet which shall verify the correctness of



the addition, and which machine, by special adjustments, may be made to print at the end of the column the sum total of the column, and to do the work in a vertically descending progression or vertically ascending progression or in a horizontal progression."

SLATE — "Slate is too much overlooked as a material for inside decoration. It exists in many different shades. It is easy and inexpensive to quarry, and by far the easiest stone to shape into pleasing forms. These qualities render it the cheapest of durable materials for interior purposes, and the wonder is that so little of it is in common use."

SPONTANEOUS COMBUSTION — "The reduction of fire risks is a most important point of economy and of vital interest to many manufacturers, or others that make use of any material or stock that is liable to be made combustible by the application of oil of any kind for facilitating its manufacture. The first care is to guard against the accumulation of such material or stock while in an oily condition, in heaps or in contact with heating pipes, or even in iron receptacles, without providing against its accumulation of heat by its absorption of oxygen from the air."

BRIDGE EQUIPMENT — "The trustees of the Brooklyn Bridge have made provisions for the expenditure of \$100,000 for new electrical equipment. Two Babcock & Wilcox boilers, of 400

horse power each, two 600 horse power engines by the Southwark Foundry and Machine Company, and two Walker generators will constitute the power and light plant. Twenty cars, 48 feet long, equipped with electric motors, will be furnished by the Pullman Car Company. Improved terminal switching facilities, coupled with the new electric equipment, will enable the headway to be reduced to one minute."

PATENTS — "The Patent Commissioner's Annual Report is a document which has a special interest in a country like our own, which owes its wealth and power so largely to the genius and patience of the inventor and to the recognition and protection which are afforded him by our admirable system of patent laws."

RIGHT-OF-WAY — "The physicians of Chicago enjoy peculiar privileges as regards transportation. For fifty cents he can procure of the city clerk a badge with a red cross which gives him the right of way. The physician can then pin on the badge and mount his wheel or carriage and all vehicles are obliged to yield him precedence."

MOTOR-CAR SPEED — "Speed in a motor carriage is desirable, but it is not, however, the first requisite, for general utility and safety are of more real importance than great speed. . . It is stated that more than five hundred applications for improvements in motor carriages have been filed in a few months in the Patent Office."

RICE — "At present rice is a leading industry in only two States of the Union, though at one time it was grown in many States. Louisiana and South Carolina are now the rice-producing States, and in these States its production continues to be profitable."

100 Years Ago in . . .



(Condensed from Issues of May, 1846)

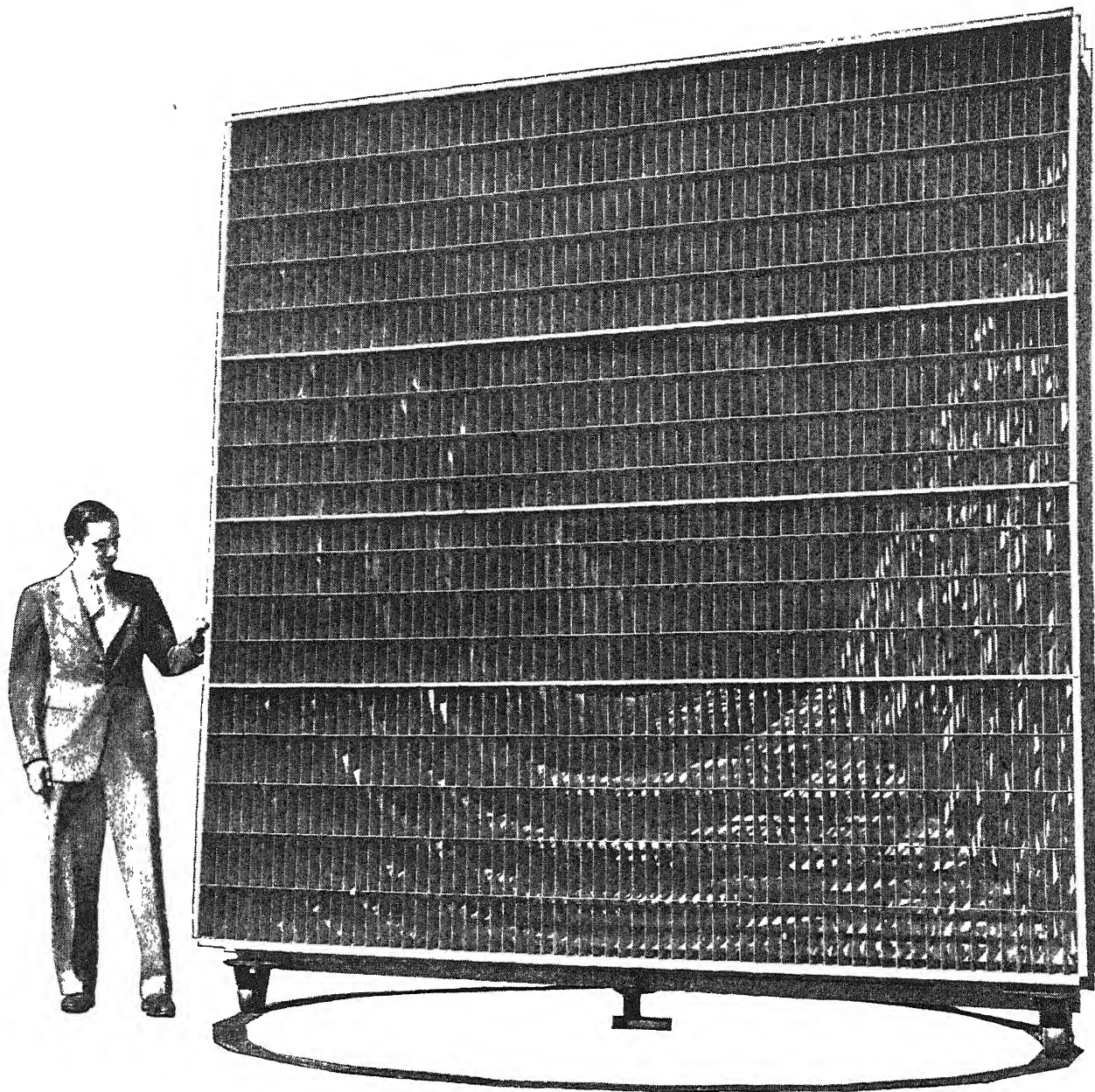
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MUSICAL TELEGRAPH — "A gentleman writing from St. Petersburg, Russia, speaks of the invention of an electromagnetic telegraph by which sounds instead of characters, are made the medium of communication. Ten wires are used, each of which produces a peculiar sound, and one or more of these sounds may be produced at the same time."

AMERICAN SILK — "We have on hand some samples of sewing silk, manufactured at Manchester, Ct., and which is at least equal to anything of the kind that we have ever examined."

TRACTION — "By the term friction, is understood the resistance which the surface of one body presents to the motion of that of another, when in close contact. Traction is a word of recent origin, and implies the same resistance, but in such a degree as to prevent any motion of the second surface on the first."



● A "SEARCHLIGHT" TO FOCUS RADIO WAVES

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they pass between the metal plates their direction of motion is bent inward so that the energy travels out as a nearly parallel beam. At the next relay point a similar combination of lens and waveguide, working in reverse, funnels the energy back into a repeater for amplification and retransmission.

A product of fundamental research on waveguides, metallic lenses were first developed by the Laboratories during

the war to produce precise radio beams.

This "searchlight" is a milestone in many months of inquiry through the realms of physics, mathematics and electronics. But how to focus waves is only one of many problems that Bell Telephone Laboratories are working on to speed microwave transmission. The goal of this and all Bell Laboratories research is the same—to keep on making American telephone service better and better.



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Previews of the Industrial Horizon

PAY AND PRODUCTION

SOMETHING of a tempest was stirred up among readers by the item "A Day's Pay For . . ." that appeared on this page, February issue. Some accused us of labor baiting; others interpreted the item as a slap at management; still others, pinkish in hue, placed all blame on the economic system of the United States. The latter are herewith quietly ignored, although their implications cannot be overlooked.

The subject of worker pay *versus* production and management profit is one that can never be settled on editorial pages; it must be thrashed out in shops and factories throughout the nation—sometimes collectively, more frequently individually. No matter how it is done, there is one premise from which all thinking must stem: Labor must be paid a fair wage for its work and management must be assured a fair profit on its investment. Labor puts its work into the pot; management puts work plus capital into the same pot. As the cooking proceeds, each must be able to take square meals out of the pot, else the whole thing becomes unpalatable for the whole country.

So now let's take a quick look at the science of labor management and see where it can fail. First, two questions. In any given plant, do the employees receive a fair wage? Do the employees give a fair day's production?

If the answer to either of these two questions is "no," it shows that something is radically wrong with the administration policies of the plant involved. Perhaps it is operating on antiquated stop-watch techniques in which standards are set by mediocre workers. Perhaps there is no merit system for upgrading and promotion from within the ranks. Perhaps there is no incentive offered for maintenance of standard performance. Perhaps there is not even an adequate method for evaluating worker worth. If any of these "perhaps" are the case, the way is wide open to worker dissatisfaction, union trouble, and all the other headaches that can beset industrial operations today.

All of this just skims the surface; the scientific solution of labor problems is a complex matter, but one that, if correctly followed through, will pay huge dividends in production, wages, profits, and general all-round industrial peace and contentment. For those interested in pursuing the subject in more detail than can be offered here, reference to further material will be given on request.

MORE ON ATOMIC ENERGY

PROBLEMS regarding nuclear energy are many-faceted, but can generally be reduced to two classifications—engineering and sociological. And for glimpses of the two horizons involved, quotes are in order:

"It seems unlikely," says Dr. John R. Dunning, of Columbia University, "that atomic power ever will really replace our common fuels in most applications. The new fuel is likely to be a supplement to existing methods. The immediate applications seem to be in the premium-fuel field, and where the special advantages of atomic power outweigh costs. There is much development to be done," Dr. Dunning continues, "before atomic power finds wide application. Many problems must be overcome, and it will be a number of years before definite practical utilization is made."

On the other side of the ledger is the matter of *how* nuclear energy will be applied—whether for the good of all or to appease the greed of the few. Says Dr. A. R. Stevenson, Jr., of General Electric Company: "Whether nuclear energy will be used for the benefit of mankind, or whether it will be reserved in dark secrecy for destructive purposes only, will depend more on our leadership as citizens than as scientists and engineers." To achieve the more desirable end, Dr. Stevenson points out, engineers will have to climb out of their specialties and look around in other fields, will have to develop a knowledge of the inexact art of human engineering, will have to expand their analytical faculties,

By A. P. Peck

and, in short, will have to prepare themselves to take an active part in the applications of atomic energy as well as in its development.

Today the world stands at a cross-road. Atomic power offers vast potentialities. Improperly channeled by the few, it can destroy every vestige of life on this planet—even that of its greedy directors—and can nullify man's laborious ascent from the caves of pre-history. Properly handled, it can open new ways of life for every man, woman, and child from pole to pole. The same engineers who have contributed so greatly to human comfort through industry are responsible for the creation of the possibility of atomic energy; they—the only ones who fully appreciate its possibilities—must make themselves equally responsible for its future use.

MORE TO COME

BERYLLIUM, obtained largely from the mineral beryl, and chemically belonging to the magnesium family, is second lightest of the stable metals. It is so brittle, however, that it is seldom used alone for structural purposes, and probably never will, extensively, because of its cost. But beryllium oxide can be used as a refractory at temperatures around 4000 degrees, Fahrenheit, and is undergoing investigation as a lining for furnaces, combustion tubes, and so on.

Most important application of beryllium today is as an alloying agent. Copper to which 2 percent of beryllium has been added shows high-strength and elasticity characteristics, even under extreme heat. More will be told about this phase of beryllium in our June issue, by Contributing Editor Fred P. Peters.

COST REDUCTION

EVER HIGHER machining speeds can do much to increase production, reduce costs, and improve products. Thus, one machine-tool maker has just announced a new group of tools in which high speeds are coupled with automatic operation, improved lubrication, and electronic controls. It is reported that these new machines will consistently increase production by at least 10 percent.

By such means as this is industry finding the answer to the problems of increasing labor and materials costs.

FOR FUTURE REFERENCE

SAYS a spokesman for the Civil Aeronautics Administration. The personal airplane must be so safe and simple that both grandmother and her sub-deb granddaughter can drive it with a degree of ease and safety comparable with that of an automobile. . . A new plant-hormone weed killer is reported to eliminate dandelions and other broad-leaved weeds in less than two weeks. . . Two-coat finishes for new wood, particularly for frame houses, use a non-penetrating primer followed by a coat of high-pigment paint. . . Color television looms large on the radio horizon: RCA has it but calls it impractical as yet—Columbia Broadcasting System is going all-out for color—Zenith Radio says that they will produce only color-television receivers—and the public (including this writer) waits with more or less patience for the final outcome. . . An alloy of germanium (by-product of the manufacture of cadmium) and gold expands slightly on solidification, melts at the low temperature of 673 degrees, Fahrenheit, is harder than ordinary gold alloys; it holds promise in dental inlays, jewelry, and electrical equipment.

PLASTICS

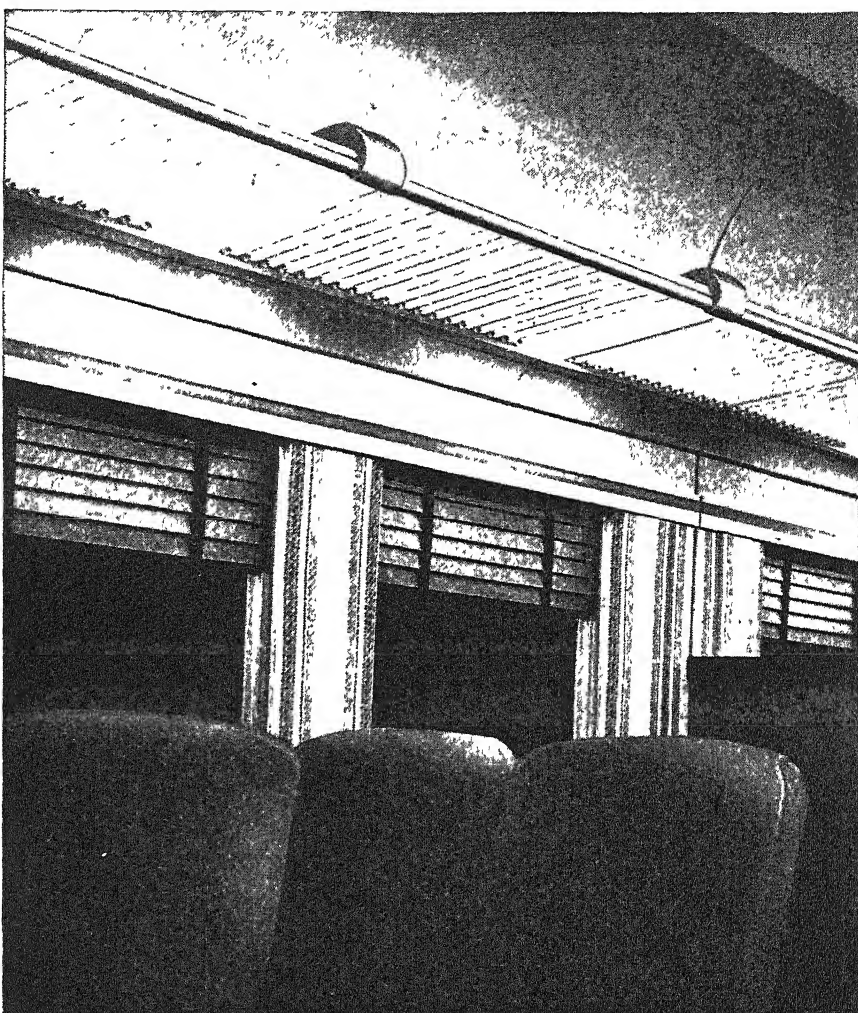
• LOOKING AHEAD •

With the "Dark Ages" of lighting behind, something more than just illumination should be expected of both commercial and domestic equipment. . . . Lighting in "meet-the-public" areas should help to create the desired atmosphere; in industry it should be a stimulus to production, worker morale, and safety. . . . Bare light alone falls short of these goals, but materials that can guide, blend, transport, and control light spell the difference. . . . Plastics are one of the best light-handling mediums.

ONE of the big difficulties in the minds of builders and designers, whether they are busy with plans for homes, offices, plants, or railroad cars, is: "What type of lighting are we going to use?" A few years ago there would have been no question in their minds. Lighting fixtures would have been incandescent—of course. But today the solution is not so easy. This last Christmas saw the introduction of round fluorescent bulbs, a development which should go far toward liberalizing the use that is made of this type of lighting. There is, too, the growing prominence of "piped" light in which the illumination from concealed fluorescent lamps is diffused over a wide area of wall or paneling.

According to a survey conducted by *McCall's* magazine several years ago, the preferences of housewives as regards lighting fixtures stood somewhat as follows: 25.2 percent out of every 100 average readers intended to install fluorescent lighting in their living rooms, 41.6 percent like it and were considering it, 2.5 percent had fluorescent light, and 30.7 percent did not like it. During the elapsed period—between 1938 and 1945—the sale of fluorescent lamps rose from 200,000 to 37,500,000—nearly 90 percent of the total going into commercial and industrial use.

With this type of lighting further stimulated by the growing popu-



Baggage rack and lighting fixtures are combined in rugged acrylic plastics unit. Railroad service affords excellent test for durability of materials and design

Partners of Light

Ideally Suited for Diffusers, Shields, Fixtures, and Glowing Radiant Panels, Plastics can Join with the Light Source Itself to Provide a Harmonious Lighting System. Strength, Light Weight, and Low Thermal Expansion All Contribute to Plastics' Growing Importance in this Field

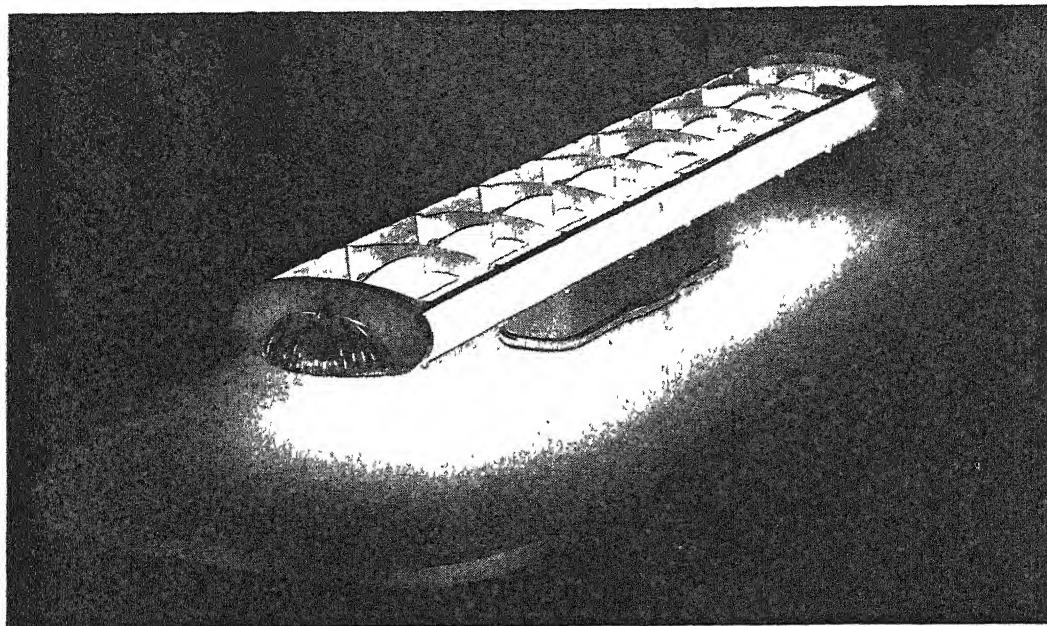
By CHARLES A. BRESKIN

Editor, *Modern Plastics*

larity of radiant light walls and round fluorescent bulbs, builders and decorators are going to find increasing uses for plastics as shields for light fixtures, for while these synthetic materials were used to some extent with incandescent

lamps they are ideally suited to fluorescent lighting.

Plastics find that the main advantage of fluorescent lighting is its coolness. This characteristic opened the field of lighting shields to the thermoplastic as well as the thermo-



Light weight and soft illumination mark attractive fixture (left) with polystyrene side and end panels

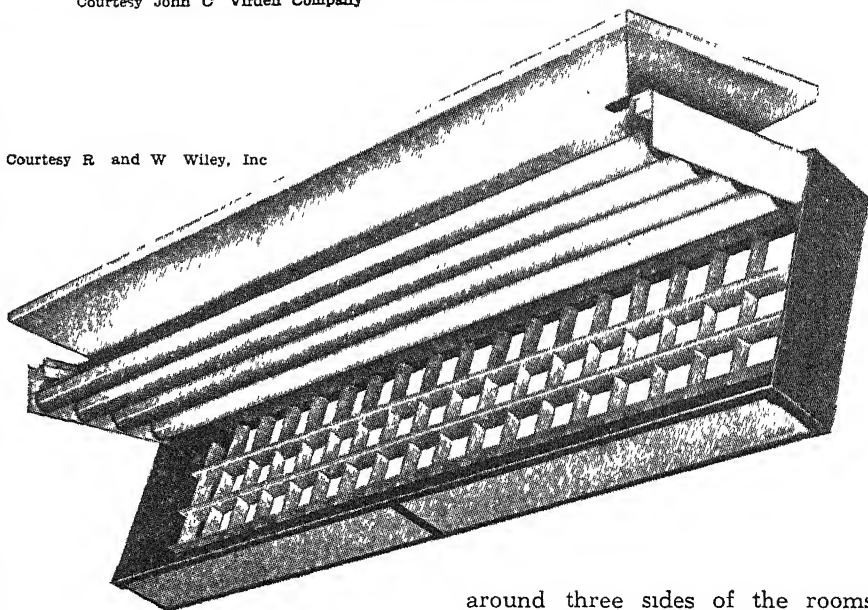
Shown in "opened for cleaning" position, fixture (below) with white translucent panels has excellent age and heat-resistance features

setting plastics materials. Of course, the thermosetting materials were used for this purpose before the introduction of fluorescent lighting, but it was either in the form of sheets or as woven monofilaments for lamp shades.

Courtesy John C. Virden Company

Because of the heat given off from incandescent lamps, care had to be taken even in designing thermosetting reflectors. An example is the semi-indirect urea lighting bowls, the first of which was made of Beetle for the Pullman Company by the Richardson Company. These were followed by a Plaskon automotive dome light produced by Chicago Molded Products Corporation and the American Insulator Corporation. In both cases, a considerable amount of designing was necessary to achieve a shape which would keep the plastics material away from the direct heat of the bulbs and ensure correct wall thickness. However, when melamines, with their higher critical temperature, came into use in this field a number of new plastics applications became possible.

Courtesy R. and W. Wiley, Inc.



Furthermore, plastics lighting bowls offered several important advantages that more than offset the problems involved in their production. They were light in weight and therefore less dangerous than glass to use and less expensive to ship: they could be mass produced with precision; they were low in cost; and they had excellent lighting properties.

Whether or not fluorescent lamp sales for residential use alone reach the 10,000,000 figures predicted for them for 1950 by the lighting industry, the 333,000,000 lamps with incandescent lights that are expected to be sold in the same year offer a wide range of uses for plastics,

since all of these lamps must be shaded and the light from them must be diffused.

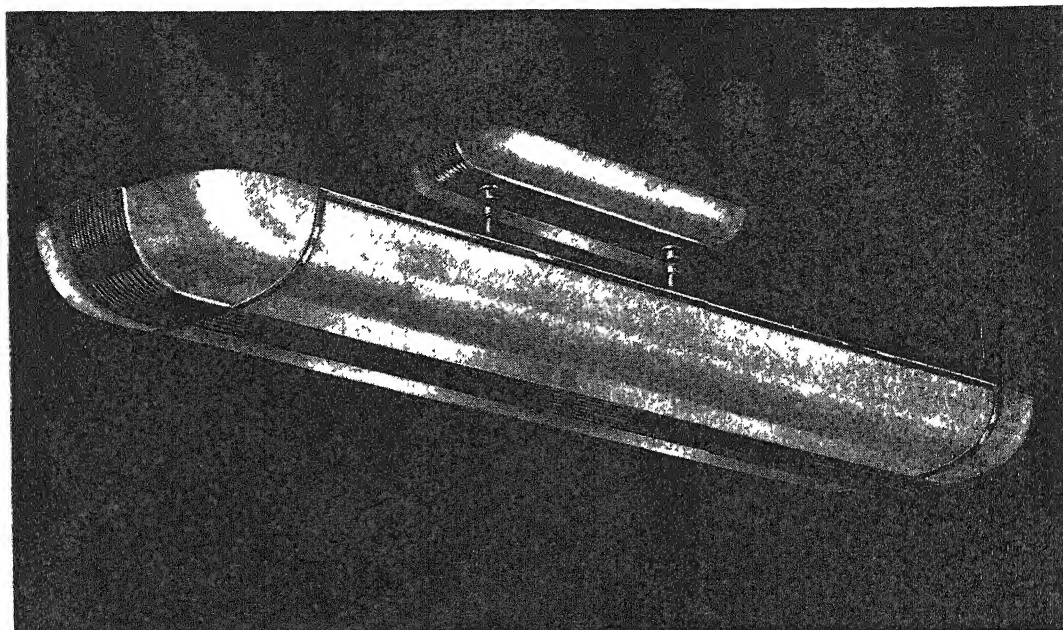
RAILCAR LIGHTING—Most indicative, perhaps, of the growing importance of fluorescent lighting is the development work now being carried on by the Safety Car Heating and Lighting Company. Although this company has used plastics lighting fixtures for a number of years, all its post-war railroad cars will be lighted through plastics shades exclusively. And the shields will not be the usual type that has become familiar to the average traveler. They are using plastics with a purpose. For example, in the mock ups of powder rooms, bedrooms, and all other places where mirrors are installed, this company is placing tubular fluorescent ceiling fixtures

around three sides of the rooms. These are set against light-colored, but not glossy, wall finishes. The result, due in part to the good diffusing qualities of plastics shields, is plenty of light on the face but little in the eyes.

More unusual still, and almost outside of the true lamp diffuser field, is an experimental Plexiglas wash basin with a Circline lamp placed under it. Here, the plastics serves not only as a light shield but also as a wash bowl. Another example of the way in which this company puts plastics to double use is the combination baggage racks and light fixtures. Heavy-gage, translucent acrylic, deeply corrugated for extra strength, is set in metal frames positioned against the sides of coaches so as to run their full length. Over each pair of seats a fluorescent lamp is set above the corrugated plastics, shielded by the metal.

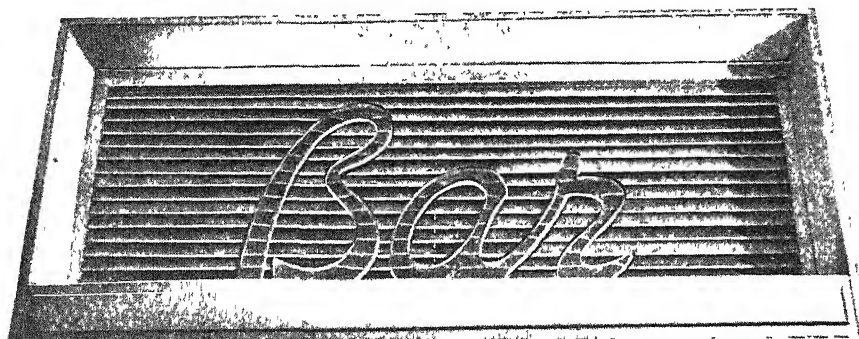
It seems probable that adaptations of some of these designs will

Advantage is taken of light-control abilities of urea plastics in semi-indirect fixture on right.



Courtesy Moe-Bridges Corporation

Another plastics characteristic, "piping" of light, makes acrylic letters of sign (below) glow with light from a concealed source



Courtesy Hotel Pennsylvania

make their appearance in hotels and restaurants, and even in private homes. For one thing, the railroad industry is a rugged testing ground of both ideas and materials. Plastics for railcar light fixtures must not only be light but they must satisfy

at least these basic requirements: good dimensional stability, expansion or contraction of less than 1/32 inch per three-foot length for every 15 degrees, Fahrenheit, change in temperature; strength enough to bear such weight as that of baggage when used in overhead racks; life equal to that of the car; flexibility enough in thinner gages to be snapped into position in fixtures, excellent light transmission qualities (82 percent in 0.060 inch thickness); and the ability to withstand vibration.

Even industrial plants do not present such severe operating conditions as do the railroads, and offices and homes even less. So lighting equipment which will stand up on the railroads should be highly satisfactory elsewhere.

DIFFUSERS—It has been stated that the ideal light is that encountered at high noon on a hazy day. Everything can be seen clearly because the illumination is high; yet there is no glare to hurt the eyes, and no over-intensity to throw color values out of scale or to create dense shadows. The fact that man is now able to rival this outdoor perfection in interior illumination by the com-

bined use of fluorescent lamps and plastics diffusers may explain why these products intrigue designers.

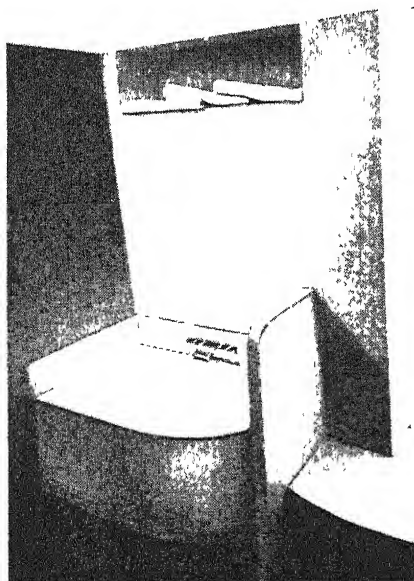
Recently the Underwriters Laboratories, Inc., when questioned regarding the suitability of all thermoplastics for lighting fixtures, authorized the following statement:

"The Underwriters Laboratories, Inc., have gone on record that they will accept fluorescent lamp holders made of polystyrene and have no objection to the use of this and other slow-burning plastics in diffusion material for fluorescent lamps in locations where normal operating temperatures are not such as to adversely affect the plastics material, thereby causing it to burn, deform, or disintegrate."

With designers and engineers planning the fixtures to suit the materials, with material makers evolving special formulations, and with molders and fabricators keeping pace with both, this statement suggests that plastics will be taking over more and more of the lamp diffuser field.

FIXTURES—This indication is borne out by both old and new plastics fluorescent fixtures. In one example, the peculiar ability of acrylics to carry light is put to use. Letters on a sign are picked up and highlighted by the light given off by a fluorescent tube hidden in the base.

Polystyrene is also finding wide use in many of the new fixtures just coming on the market. A shield, sold by the John C. Virden Company, has the side panels extruded and the end cup molded of this material. Both parts are produced by the General Electric Company. The advantage of polystyrene in this application is that it has the appear-



Courtesy Safety Car Heating and Lighting Company

Lighted from below by circular fluorescent tube, plastics lavatory symbolizes range open to designers in this field

ance of crystal-clear glass; yet is a fraction of the weight of glass. In addition, it is rigid and permanent, and in the form selected it provides prismatic diffusion. The company is also experimenting with tinted polystyrene and is working on matching finishes for the exposed metal parts of the lamp fixtures.

Another lighting company, R. and W. Wiley, Inc., is using white translucent Vinylite, choosing this material because of its dimensional stability, color quality, pliability in heat and cold, resistance to change due to moisture and age, and non-support of combustion. They have developed a rather unusual light shield so constructed that the plastic sides can be opened easily to allow for cleaning.

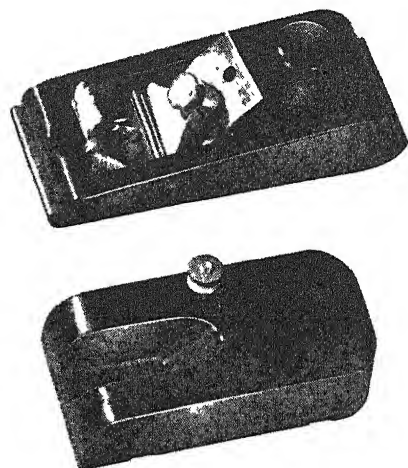
One of the earliest uses of plastics in fluorescent lighting was in Louverplas, made by the Doane Products Corporation from Plasta-cele. This acetate product is a lamination of sheets of clear and colored acetate, sliced to make a thin sheet with built-in louvers of white, black, or pink. It can be either polished or given a prismatic ribbed surface

and is commonly used for the control of glare.

And then there are the combination Plaskon housings and Vinylite sheet canopies for semi-indirect commercial fixtures brought out by Moe-Bridges Corporation and molded by Plastics Engineering Company. Beetle also has been used by this company for reflecting shields and bracket housings, while the F. W. Wakefield Brass Company has produced a fixture in which extruded Tenite II is the diffusing material, the plastics being supplied in 48¼ inch lengths by Sandee Manufacturing Company.

Experimental work is under way on applications of translucent contact laminations, larger and longer plastic extrusions, architectural panels for whole ceiling diffusion, and black-light filters of cellulose acetate butyrate to reflect luminous pigments. Moreover, bigger fixtures for commercial use are planned. This will mean increasing necessity for decreasing weight—and will broaden the utility of plastics for designers and users of such lighting equipment

ucts Company. Although small in size, there is nothing of the toy about either of these tools. The plane can be used for delicate work as well as heavy-duty planing and shaving, being strong, well-balanced, and



Precision tools, plane (above) and stripper (below) are sturdily made

equipped with a high carbon surgical steel blade. It is molded in one piece with no inserts. The polystyrene gives good dimensional stability; the bulk of the piece provides good impact strength.

The stripper is equipped with two knives for cutting strips of balsa 1/16 to 1/2 inch wide out of stock 1/32 to 3/16 inches thick.

MOLDED RIM

*Holds Wire Mesh
Firmly in Place*

TEA STRAINER problems appear to be solved by a new unit molded by Plastic Metal Manufacturing Company, in which the metal mesh forming the strainer is molded right into the edge of the transparent



Molded strainer is heat-resistant

Styron sides. The only limitation is the suggestion by the producer that the strainer not be used where the liquid to be strained is hotter than the boiling point of water.

LEATHER-LIKE

*Coated Fabric
Resists Sun and Rain*

BABY CARRIAGES are now being brought out with bag and hood covered with Terson, a resin-coated fabric. Athol Manufacturing Company developed the leather-like ma-

terial which resists sun and rain and has a long life span. Because it is also resistant to cracking, abrasion, and puckering, and because it has good elastic properties, the fabric appears to be well suited to this and other out-door uses

COCKTAILS IMPROVED

*By Use of Vinyl-
Lined Container*

ALUMINUM cocktail containers, coated on the inside with Cordo-Clad, a vinyl-resin blend, offer an advantage over older containers in that the inner coating prevents any possible transfer of metallic taste since the liquid does not come in contact with the aluminum. The Elliott Manufacturing Company fires the vinyl, purchased from the Cordo Chemical Company, right into the metal to form an integral part of the container wall.

HOBBY TOOLS

*Made of Plastics
For Special Uses*

INDICATIVE of the spread of many hobbies is the development of tools for the exclusive use of hobbyists, yet which match the best full-size woodworking equipment in quality and usefulness. For example, there are the plane and the balsa stripper molded of polystyrene that is being put out by X-Acto Crescent Prod-

REFRIGERATOR PLASTICS

*Show Trend Toward
Wider Use*

NEW REFRIGERATORS will be equipped with a number of new operating and use features, and in many cases the new parts will be made of plastics. In one line of refrigerators, for example, a standard part on all models is an inner door panel molded of Capac, a laminated paper impregnated with phenolic resin. This material was chosen because it combines production economy with good thermal insulation characteristics.

Extensive use is also made of polystyrene. It appears as cold-control knobs and escutcheons, the material being supplied by the Bakelite Corporation, Dow Chemical Company, and Monsanto Chemical Company. Polystyrene is also used for evaporator doors, the fronts of hydrator units, and deep-freeze compartments.

And finally, there are Bakelite handles plated with metal, Lucite or Plexiglas nameplates and trim, and a storage tray composed of two pieces of compression molded laminated paper.

Wooden Wealth

Raw Materials and the Ingenuity to Use Them are the Fundamental Wealth of a People. Depletion, a Constant Threat to Some Materials, Emphasizes the Potentialities of Wood as a Chemical Storehouse. Chemurgy—the Ingenuity Factor—is Expanding Now, Holds Great Promise

By HOWARD C. E. JOHNSON, Ph.D.

Chemical Editor, Chemical Industries

A REVOLUTION is coming in the chemical industry. Not tomorrow, and perhaps not for 50 or 100 years, but it is coming. Petroleum and coal now stand supreme as veritable treasure chests for the organic chemist. But, although the experts disagree as to how long our reserves of these materials will last, it seems certain that the bottom of the barrel must eventually be reached.

Then it will become necessary to depend upon storehouses of energy that do not require geological ages to make, materials that can be grown on a short-term, crop basis. This means an ever-increasing utilization of such materials as wood, grains, grasses, and the like. It also means that chemurgy (chemistry based on agricultural products) will ultimately become a science of prime importance.

Wood, as a chemical raw material, is not new. Distillation of wood to

produce acetic acid and wood alcohol is traditional, as is the production of turpentine and rosin from pine stumps and trees. Quinine, logwood, and quebracho are other wood products with long and useful histories. The newer technology, however, has greatly extended the range of materials obtained from wood, and one of its more salient features is the economical utilization of wood waste. Sawdust and small chips, which formerly were good for nothing except burning, are now being converted to many products. Some of these products are immediately useful; others cannot compete economically—now—with products from other sources but hold both promise and hope for the future when irreplaceable raw materials are gone.

ALCOHOL — Although wood has been largely superseded by synthetic processes for the production

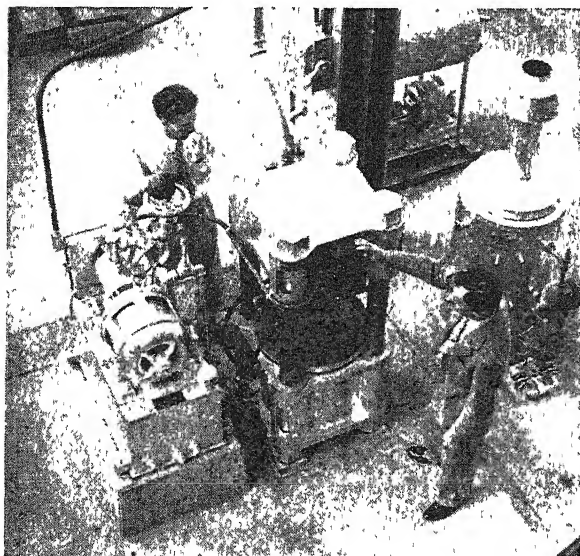
• LOOKING AHEAD •

Scare headlines are legion, but the day when serious shortages of irreplaceable raw materials force chemurgy on the industrial world may yet be far off. . . Careful analysis, however, of non-timber uses for wood—a material about which too little is known even today—may bring dividends in useful applications for waste products. . . At present, the economic picture appears marginal for alcohol and some other products made from wood, but continued research may make them profitable.

of methanol and acetic acid, there has been increasing interest in the past few years in wood carbohydrates as a source of ethyl alcohol.

Very recently, the first successful plant for the manufacture of alcohol from the waste liquor of sulfite pulp has been put into operation by the Ontario Paper Company. Not only does this waste material provide a cheap raw material source for alcohol, but also the very annoying problem of stream pollution arising from its disposal has been solved by utilization of its constituents.

In the production of sulfite pulp for paper stock, wood chips are cooked with calcium bisulfite. During this cooking, about half of the wood material is dissolved or decomposed. Some of the dissolved material is sugar, normally present in the wood, and more sugar is formed by breakdown of the cellulose fibers. The total sugar content of the cooking liquor, then, is 2 to 4 percent, and 8 to 10 tons of liquor



A hydraulic press for making lignin plastics in pilot plant. Little is known about this material and many problems beset its use in plastics

is obtained for each ton of pulp.

The waste liquor is first cooled, aerated to blow out the sulfur dioxide, and then neutralized with lime to reduce the acidity to a degree suitable for fermentation. The lime sludge is separated and the clear liquid is then pumped to the fermenters where yeast and a trace of nutritive salts are added. Fermentation is allowed to take place, after which the yeast is separated for re-use by centrifugation in a manner similar to the separation of cream from milk. Finally, the clear "beer," containing about 1 percent of alcohol, is distilled to 192 proof. More than 18 gallons of alcohol are obtained for each ton of pulp produced, and it is expected that the yield may be raised to 25 gallons when additional equipment is available.

Essentially the same process has been used in Europe—particularly in the Scandinavian countries—for over a decade, but the Canadian installation is far more efficient. It is estimated that there are some 35 pulp mills in the United States whose daily pulp capacity is over 100 tons, the minimum for economical alcohol operations. If alcohol plants were installed at each of them, they could produce about 50 million gallons of ethyl alcohol a year at a cost, not including overhead and amortization, of 8 to 12 cents per gallon, depending on the size of the plant.

At this cost, alcohol production from sulfite pulp liquor might still be considered marginal. The process nevertheless points the way to economic utilization of one of this continent's greatest industrial wastes. Also, virtual elimination of the stream pollution nuisance can be one of the most important returns from such alcohol plants at pulp mills.

In the west, a new plant is pro-

ducing alcohol directly from wood waste. Here, the unusable wood resulting from logging operations is chipped, digested with dilute sulfuric acid, and then neutralized, fermented, and distilled essentially as in the Ontario plant. About 230 tons of waste wood are processed per day to give 11,500 gallons of 190-proof alcohol—a yield of about 50 gallons per ton.

The project was conceived as an emergency measure to help fill the alcohol drums for war purposes. Whether it can continue to operate profitably in peace-time depends upon many factors. Representatives of the United States Forest Products Laboratory are of the opinion that wood waste should not have any difficulty competing with grain crops as a source of commercial alcohol "if the farmer gets a reasonable price for his crops." They do admit, however, that there is a question about its being able to compete with "give away" prices for molasses, or with alcohol from petroleum gases. To a large extent the economics of the process will depend on whether or not profitable outlets can be developed for the lignin, amounting to almost half the weight of the dry wood, which is obtained as a by-product. At present the cost has been estimated, exclusive of amortization, at about 13 cents per gallon.

LIGNIN—Profitable use of the by-product lignin would make alcohol production from wood more economical. An interesting development of the last few years is the production from lignin of vanillin, the aromatic constituent naturally occurring in the vanilla bean. The structure of lignin is not entirely known, but it is expected that other compounds similar in structure to vanillin may soon be produced from it. Indeed, studies being carried out

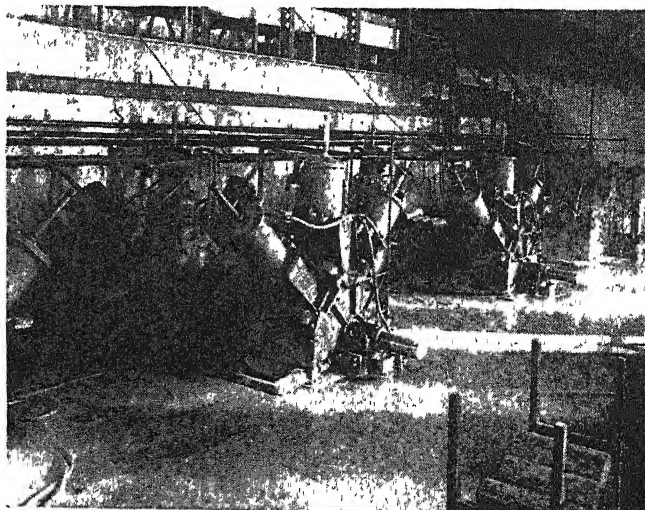
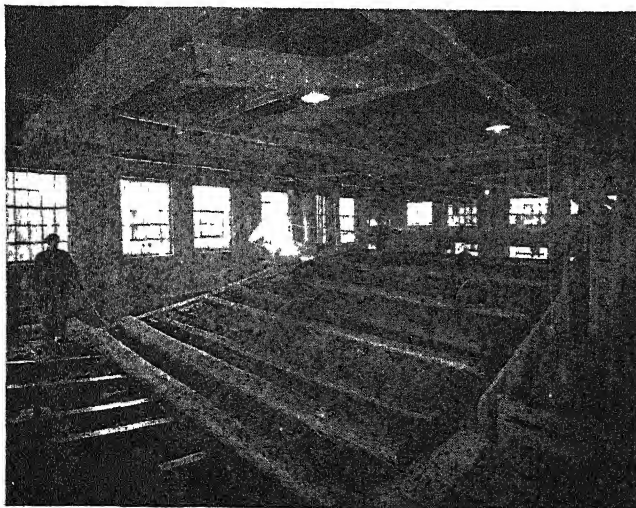
in several industrial and university laboratories on the structure of lignin may eventually make this material an important source of organic chemicals.

At present, however, the chief outlet for lignin appears to be in plastics. A simple treatment devised recently at the University of New Hampshire provides a water-resistant wallboard of the Masonite type.

To produce this material the lignin is simply heated with a 10 percent solution of zinc sulfate for two hours. The lignin is then separated from the reddish-brown liquid and subjected to the action of hydrogen sulfide gas. After air-drying and molding at 300 degrees, Fahrenheit, under a pressure of 2000 pounds per square inch—ordinary commercial practice—the resulting material has properties which compare favorably with those of Masonite. If the material is further treated with formaldehyde after the hydrogen-sulfide treatment, the characteristics are markedly improved. Neither this product nor Masonite itself, which is produced from wood fibers disintegrated by steam "explosion" of wood chips and then subjected to high pressure, can be considered true plastics, however.

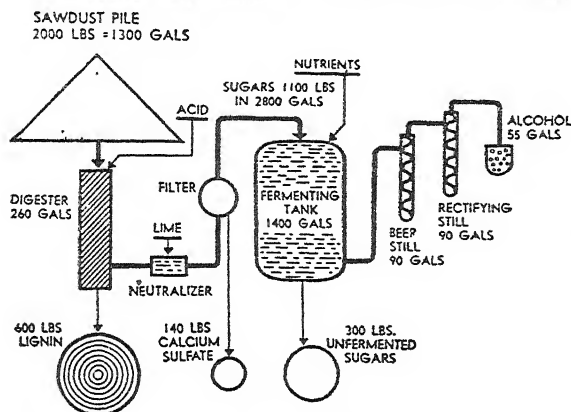
LIGNIN PLASTICS — The United States Forest Products Laboratory has experimented with the treatment of wood itself, in the form of sawdust, to produce so-called "hydroxylin" plastics. The sawdust is cooked either with dilute sulfuric acid or dilute aniline. Dried, ground, and molded with suitable plasticizers, or merely with water, dense black plastics are obtained which have excellent characteristics.

Partial hydrolysis of wood fiber gives hignocellulose, a material in which plastic properties are inherent. It cannot be used alone effec-



Five-saw slasher (left) and pulp wood grinders (right) are initial steps in wood processing

Processing stages in conversion of wood waste to alcohol Lignin at lower left, a by-product, may be key to more profitable use of this process



utilizing waste products. Eventually, perhaps, the tons and tons of wood waste which are daily poured into our sewers will provide the basis of a profitable chemical industry.

PRESSURE DISTILLATION

Gives Major Savings in Water Purification

DISTILLING water by utilizing the heat produced by compressing steam is a method that has been successfully employed in purifying sea water for drinking purposes. Instead of using fuel to boil the water, compression distillation burns the fuel in an engine to produce power to compress and thus heat steam in the system. When this heated steam is condensed, it gives up its heat to boil water and thus produces more steam to be compressed. Efficiencies as great as fifteen times those achieved in the ordinary method of distillation are possible. Not only is the new system successful on shipboard but it also promises important savings in industrial applications requiring distilled water.

FORTIFIED GLUES

Resist Tropical Conditions; Are Easy to Use

LONGER life for furniture, musical instruments, and other wooden products exported to the tropics is promised through the use of new fortified animal glues, developed by glue manufacturers in conjunction with independent laboratories.

Making use of formaldehyde solutions and organic fungicides-bactericides, these glues were originally formulated in response to war-time demands to protect glued assemblies destined for such areas of high humidity and temperature as the Burma theater.

Procedures used in preparing the glues are simple for the wood-working plant to adopt. No equipment changes or additions are necessary, and only two deviations from the customary procedure in the use of animal glue for joint work are involved.

First, the usual glue solution is made resistant to molds and extraneous bacteria by addition to the dry glue of 0.5 percent by weight of an organomercuric fungicide. Secondly, provision is made for pre-treating one side only of the assembly with a dilute formaldehyde solution, allowing the wood surface to absorb the free moisture before joining with the matching wood surface to which a film of glue has been applied in the usual manner.

tively, but the Northwood Chemical Company uses it with standard phenol-formaldehyde and phenol-furfural resins to produce useful materials at low cost. Other manufacturers are also investigating the process.

Another use of lignin plastics is in paper laminates. Marathon Chemical Company applies a lignin-enriched pulp to make a paper suitable for laminating with or without auxiliary resins. "Lignolite," the material so produced, can be readily drilled, sawed, turned, punched, and machined. Its excellent mechanical and electrical properties make it generally suitable for switchboards, switchbases, barriers, spoolheads, connection blocks, terminal strips, insulating spacers, mounting plates, washers, supports, cabinets for housing electrical equipment, and the like. It also has many uses other than electrical, including signs, nameplates, iceboxes, ice-cube trays, shower stalls, table tops, handles, and so on.

While Masonite is hardly a plastics, a modification of the process gives a material that may be powdered and molded into a dark, hard, water-resistant product. A similar product is made from redwood and marketed under the name "Shell-erite" by the Sheller Manufacturing Company for such uses as steering wheels.

Robert S. Aries, of the Northeastern Wood Utilization Council, has recently written of lignin plastics, "Presently known lignin plastics do not, in general, have properties of their own which cannot be easily or economically duplicated by other plastics.

"It is difficult to base predictions of future possibilities on the basis of present performance, as research may alter the picture overnight. . . The future of lignin plastics clearly is in the hands of the chemist and engineer. The utilization of the available tonnages of waste lignin and the large additional amounts

which could be produced will require the ingenuity of the research worker and the development engineer. Besides plastics and low-priced board-type products, other outlets should also be investigated, since plastics cannot be considered a panacea for all waste-disposal and by-product problems. Present work will yield new and improved substances of a resinous nature, and it may be expected that a number of new marketable products of lignin will soon make their appearance on the market. Research may transform lignin into a lucrative raw material of the future and place it in the permanent picture of the American chemical and plastics industries."

OTHER WOOD PRODUCTS—While cellulose—whose uses in paper and rayon are already established—and lignin—for which uses are being found—are the large-tonnage constituents of wood, other materials are also finding new uses. The Department of Agriculture, for example, is developing methods of obtaining myrcene and isoprene from turpentine. Isoprene is the building block of natural rubber, and myrcene is a highly unsaturated compound formed from two isoprene units. Myrcene has now been developed to a point where it may have application in the manufacture of certain types of synthetic rubbers.

In Germany during the war, 14 tons per day of dry yeast were produced from the waste liquor of a beechwood pulp plant which used 200 tons of dry wood daily. The yeast, containing 40 to 50 percent protein, was used to produce soup powder and other protein-containing foodstuffs, chiefly for the army. This wood food product sold for half the price of lean meat.

The research being done today by a wide variety of organizations portends that the traditional uses of wood and wood products will be augmented and complemented by a host of new uses, aimed chiefly at

Aircraft Radar

Often Hailed as a Cure-All for Commercial Aviation Difficulties, Radar Alone is Insufficient. It Must be Combined With Other Navigational Aids Before its Full Possibilities can be Realized. Several Systems, Surveyed Here, Offer Possibilities for Further Development

By VIN ZELUFF

Associate Editor, *Electronics*

SEVERAL different systems of navigation and traffic control for aircraft, utilizing television and radar techniques to present visual information directly to the pilot and to dispatchers on the ground, are now under development to cope with the expanding all-weather needs of commercial and military aviation. The ultimate choice of one system for the commercial airways will, of course, involve financial and political aspects, but the technical details will also have an important bearing on the decision as to which electronic system will be used to make timetables of airlines as reliable as those of railroads.

For control of traffic, accurate position data on all aircraft within the

control area must be presented to the traffic control personnel, and resulting traffic instructions must be relayed to the pilot rapidly enough to be useful. Adequate warning must be given of impending collisions between aircraft, or between aircraft and the ground or fixed objects. The system must operate in conjunction with existing navigational and weather-data aids

TELARAN—Use of radar alone for air navigation has several serious limitations. The equipment is relatively heavy and bulky for a plane, and requires skill for its operation. Furthermore, it provides no data on the ground for the use of the traffic controller. Ground radar, on the

• LOOKING AHEAD •

Television will play an important part in the future of aerial navigation. . . If predictions of half a million planes in the air within the next 10 years are realized, there will be a vast market for electronic navigation aids. . . Regardless of numbers of planes, aerial safety will be prompted by electronics. . . Demands offer possibilities for further development of existing and proposed systems.

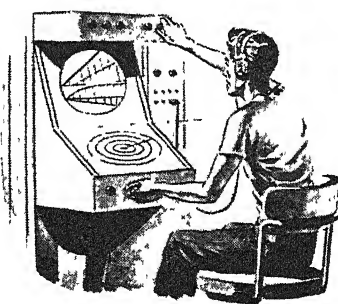
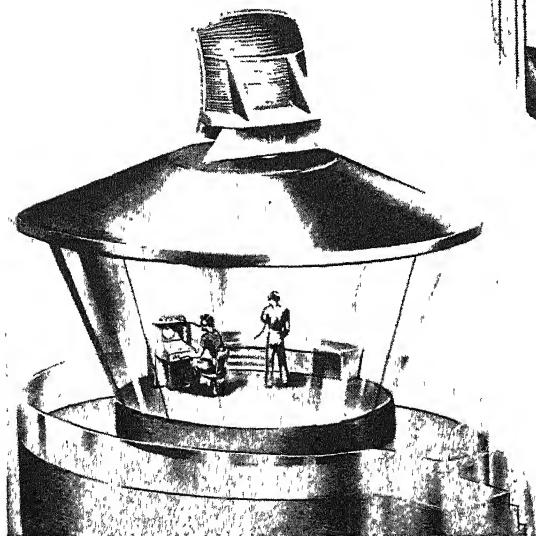
other hand, cannot by itself help the pilot. One answer may be the use of Teleran (a contraction of "television, radar, and air navigation"), proposed by RCA engineers, in which aircraft positions are determined by ground-based microwave radar equipment. The resulting pictorial information is combined with other graphic information, such as control instructions, maps, and so on, and transmitted aloft by television.

Since a composite picture of all aircraft at all altitudes would be confusing to the pilot, Teleran includes a system of separating signals received from aircraft at various altitudes, and transmitting a separate picture for each traffic level. Commercial aircraft move rapidly horizontally and slowly vertically, so the pilot needs information on objects many miles from him horizontally but not on objects more than about 1000 feet above or below him.

The basic Teleran system includes a long-range ground-search radar, a short-range ground radar, ground selection of codes to separate the signals received from various altitude levels, television cameras for picking up the radar presentations, a television transmitter for sending the pictures aloft, and a television receiver and transponder in each aircraft.

The transponder is a radio beacon which produces a clear image

Control tower (below) of Gilfillan ground-controlled-approach landing system mounts a rotating antenna on top that searches 2800-square mile area of air space every two seconds



Cathode-ray screens (above) at ground-control operator's station, search indicator is on lower panel, azimuth and elevation indicators above

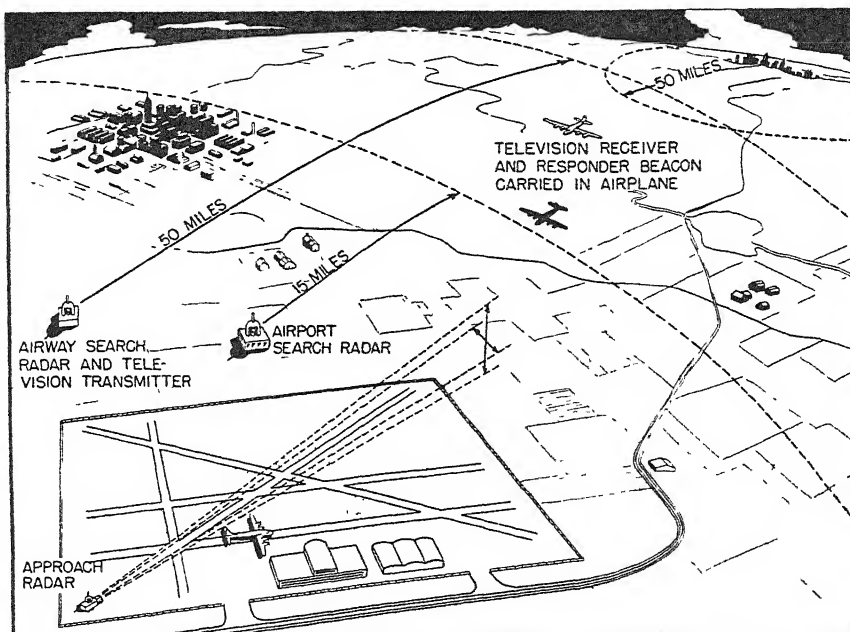
on the ground radar screens and permits altitude separation. The transponder is tied into the barometric altimeter so that its transmitted signal is coded in relation to altitude. Each pilot sees his plane as a spot moving on a map reproduced on his television receiver. He can identify his own plane by a radial line which appears in the picture and passes through his position on the map.

Should anything fail in either the ground or the airborne part of Teleran, the pilot will not receive false or misleading indications because he gets either a complete television picture or nothing at all.

GCA — Arrival and departure of commercial aircraft may soon be scheduled to and from airports without regard to the weather, by means of an Army-Navy radar equipment that has been used since early in 1945 to land aircraft during weather conditions of near-zero ceiling and visibility. This radar system, which makes closed-in airports a thing of the past, is known as "ground controlled approach" (GCA). The system can provide around-the-clock airport traffic control regardless of weather conditions.

In the GCA system, manufactured by Gilfillan Brothers, Inc., two microwave radar systems on the ground reveal the exact position of an incoming aircraft with respect to the landing glide path and permit the ground operator to radio precise flight instructions to a pilot coming in through zero-zero weather. One radar "search" system operates to aid in or control the homing, holding, stacking, and traffic pattern operations of aircraft. The second system controls the aircraft during its actual let-down along a predetermined glide path. No special equipment is required in the aircraft other than ordinary air-ground radio communications equipment.

The search radar system provides the GCA ground operators with information on the azimuth bearing and range of the plane from the airfield at distances up to 30 miles and at altitudes up to 4000 feet. The antenna is continuously rotated so that its transmitted and reflected pulses examine the space around the GCA location. The echo pulses received by the antenna are fed through electronic amplifiers that conduct them to a cathode-ray tube in the equipment. This is a high-persistence cathode-ray tube that displays the transmitted pulse at its center, and has an illuminated line from the center of the tube to its outer edge to display the azimuth of search.



Teleran installation showing station ranges. Information vital to individual planes is selected from composite traffic picture and relayed by television

With the search system, aircraft can be held at a given point and stacked in altitude prior to landing. It serves to line up the aircraft in azimuth with the second radar system. The latter is a precision system that provides operators with accurate information on azimuth headings, altitude, and range up to 10 miles. For more precise close-in work, a two-mile indication is also provided.

Instantaneous recordings are made on the screen of the cathode-ray tube, showing azimuth error in degrees and elevation deviation in feet with respect to the correct approach line and angle. This information is then relayed to the pilot who makes the proper corrections in heading and rate of descent.

The combination of the search and precision radar systems, the air-ground radio telephone, and the intercommunications system between operators, enables the GCA controller to give positive, accurate data on an aircraft's range and bearing from the airport. The pilot is given altitude, range, and bearing information in the last 10 miles of the approach which enables him to bring the plane to within a few feet of the ground.

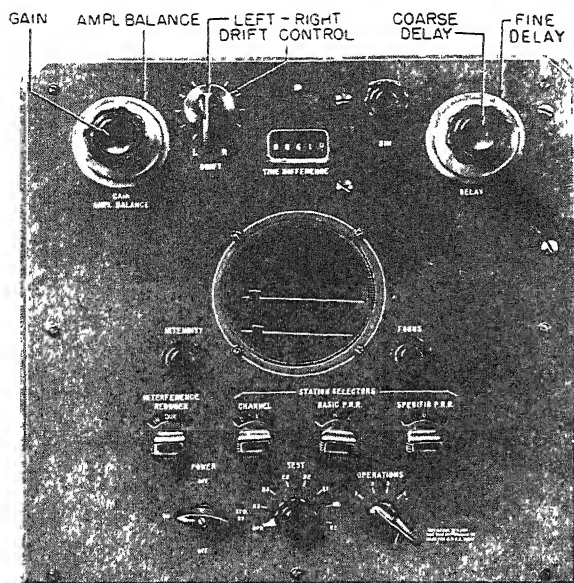
As used by the Army, GCA makes regular flight schedules possible around the clock when airfields are completely closed in by fog.

LANAC—A new war-born system for protection and navigation of aircraft while in flight, proposed by Hazeltine Electronics Corporation, is called Lanac, abbreviation for "laminar-air-navigation and anti-collision" system.

The system is based on the fact that aircraft in flight are restricted to certain laminae or air strata and that it is essential for these planes to know what obstacles are present in their respective strata of operation. Lanac makes it possible to prevent collisions between planes in the air or between planes and mountains, high buildings, or other fixed obstacles; identify individual planes while in flight as to airline and flight number; furnish direction and other data to the pilot without help from a ground crew; increase traffic-handling capacity of airways and airports; increase the safety of long distance flights; reduce the possibility of lost planes; and give airports and ground check stations continuous data on the location as well as the identity of all planes in the air.

Under the Lanac system, every airplane would be equipped with a challenger and a replier. These are radar sending and receiving sets controlled by barometric devices so as to be responsive only at the altitudes for which they are set. The challenger sends out a constant series of signals that are automatically picked up by the repliers of other planes in the same air stratum. Upon receipt of such signals, the replier automatically transmits a reply so that the presence of another plane in the same stratum is instantly known and collision can be avoided.

When ascending or descending, the pilot can temporarily change the barometric range of his challenger to investigate the air layers he is approaching. Through barometric selection, a plane in normal



Control panel of direct-reading type Loran indicator. Loran differs from radar and television applications, functions on an electronic stop-watch principle

Courtesy Sperry Gyroscope Company, Inc.

operation is advised only of obstacles in its own stratum of flight and is not confused by a multiplicity of signals from other strata.

Mountains, high buildings, and other fixed obstacles can be equipped with permanent repliers which will be responsive to challenges transmitted by any planes flying at a dangerous altitude.

Plane identification is obtained by varying the reply signals in Morse code to give the letter designation of each individual plane. This information can be picked up by other planes and by ground stations.

For navigation, the pilot of a Lanac-equipped plane will be able to challenge beacons on the ground and receive their coded replies. With these navigational fixes the pilot can establish his exact position and determine his ground speed. These navigational beacons would be located at strategic points.

LORAN—A system of radio navigation which permits the navigator of an aircraft to determine his position at distances up to 1500 miles from shore-based stations at night, or 750 miles by day, by measuring the relative time of arrival of two or more radio signals sent synchronously from known points, is known as Loran ("long-range navigation").

Loran uses frequencies from 1700 to 2000 kilocycles (just above the broadcast band) and is substantially the same as the British "Gee" system that guided high-flying bomber aircraft over Germany. The Loran system involves a grid of radio signals across the earth's surface that are transmitted by numerous pairs of synchronized "master" and "slave" radio transmitters. Each master transmitter sends out radio

pulses at fixed intervals; its slave transmitter (often hundreds of miles away) follows with a second series of pulses.

In the plane, the navigator uses his receiver-indicator to measure the number of microseconds of time-difference in the reception of the two sets of signals. He then consults a Hydrographic Office Loran chart which contains hyperbolic lines in color—a different color for each pair of stations in his area. To get his exact location, he switches his receiver-indicator to measure the time difference between another set

of signals from a different pair of transmitters. By tracing the new line (of different color) he finds its point of intersection with the first line and thus determines his exact location on the chart. Under ideal conditions, Loran can locate ships or planes within a radius of 500 feet.

Besides its use over Germany during the war, Loran was the electronic guide for transport planes over the "Hump" between India and China and for B-29's after bombing Japan. Its maximum service area now covers more than half the area of the earth, and it can be used by both aircraft and ships.

TRAFFIC DEMANDS—At the present time, instrument-landing equipment is being installed by the Civil Aeronautics Administration at nearly 100 airports in this country. This is the three-element system developed by the CAA, consisting of a localizer, glide-path, and marker beacon. (See *Scientific American*, June 1945.)

Although the CAA favors gradual replacement of existing equipment after thorough tests of proposed systems, aviation experts agree that considerable development work will be necessary before radar techniques will be applied to commercial aviation. Acceleration of such development may take place, however, if the presently predicted 500,000 planes take to the air within the next 10 years.

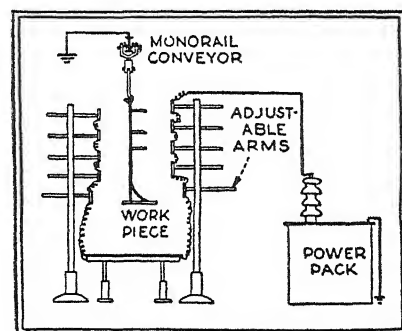
ELECTROSTATIC PAINTING

Assures Even Deposit Of Surface Coating

ELECTRONIC tubes provide high-voltage power for equipment being used in the electrodepositing of sprayed paint to achieve uniform coatings. The same equipment can be used to de-tear edges on pieces painted by the dip process.

An electric field is set up by fine wire electrodes positioned around the article to be coated, the article itself being at ground potential. These electrodes are fed pulsating d.c. power at voltages on the order of 100,000 volts.

Objects being coated do not necessarily have to be made of electrically conductive material. Wood and pottery parts have been satisfactorily handled. As an example of uniformity of coverage, it is possible to coat all sides of a part without turning it toward the source of the spray. The particles of paint which pass around the sides of the object turn



Adjustable arms accommodate electrical field to various sized painting jobs. For de-tearing, polarity is reversed

in flight like homing pigeons and strike the rear.

For removing tears or drops of surplus paint, the electrode structure is replaced with a heavy grid and the dipped parts are stripped of surplus paint by reversal of polarity. This makes it possible for the paint chemist to formulate his finishes without regard to teared edges and thus use a wider selection of materials.

Speculum For Brightness

• LOOKING AHEAD •

An ancient alloy, formerly used only in cast form, is bowing to the science of electroplating. . . When tin once more becomes plentiful, speculum plating will open new markets for it. . . Decorative possibilities of speculum plating run the whole gamut of metal uses, from the kitchen to jewelry. . . Not suitable yet for automobile trim and other outdoor uses, but research continues.

A NEW type of electroplated coating with a very old name has entered the highly competitive decorative finishes field and promises to find a permanent and increasingly important place among metal coatings. Known as speculum plating, and developed in England, the new coating looks like silver, has a hardness between that of nickel and chromium, possesses good resistance to tarnishing, and is relatively inexpensive.

Speculum is expected by its developers, the Tin Research Institute, of London (the American offices of the Institute are at Battelle Memorial Institute), to become in time a major rival of silver, nickel, and chromium as a decorative finish. First adopted commercially in Birmingham, England, in 1939, it was abandoned when bright metal finishes were eliminated in the interests of conservation, but was revived during the war for a few special purposes, such as non-magnetic metallic reflectors for certain aircraft instruments. Several commercial shops have been installed in Britain for these applications; full utilization has been held back, both in England and in the United States, by the tin shortage, but once tin becomes plentiful again and American designers and electroplaters are able to investigate the advantages and limitations of the new finish, it is expected to find wide uses. At present the sole

Electrodeposited Coatings of Speculum—An Alloy of Copper and Tin—Give Good Tarnish and Wear Resistance. Speculum is Less Expensive to Apply than Silver or Chromium Plating and Cuts Labor Requirements Considerably. Future Applications Will Cover a Broad Range

By FRED P. PETERS

Editor-in-Chief, Materials & Methods

American licensee is the City Auto Stamping Company in the mid-west.

AN ALLOY—Speculum is an alloy coating containing about 45 percent tin and 55 percent copper; actually it is a "white bronze." The alloy coating has been called speculum because its nominal composition and characteristics are similar to those of speculum mirrors first made by casting the alloy more than 2000 years ago. The only mirrors produced by the Romans were solid metal castings, the two most popular materials of that era being silver and speculum; the rapidity with which silver became tarnished and scratched retarded its general use and the speculum mirrors remained in wide use for 1000 years until the art of silvering glass was perfected.

The cast speculum mirror re-

gained its prominence for a brief period in the 18th and 19th Centuries for making large diameter reflector telescopes. Thus, William Herschel made speculum reflectors up to 48 inches diameter with 40-foot focal lengths; he discovered Uranus and doubled the size of the then known solar system. Later, the Earl of Rosse cast speculum reflectors 6 feet in diameter with 60 foot focal length, which revealed many hitherto unknown star clusters.

These speculum reflectors were massive castings and the difficulties that had to be overcome in their manufacture may be gaged by the fact that they took about three years to make. Also, they were lower in tin content than the electroplated speculum coatings of today, the composition of the cast alloy vary-

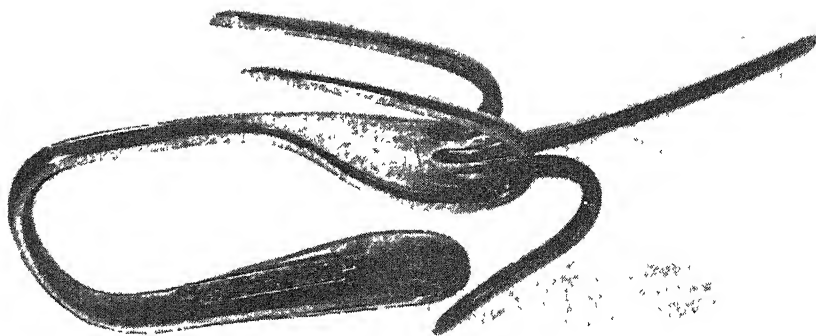


Photographs courtesy Tin Research Institute

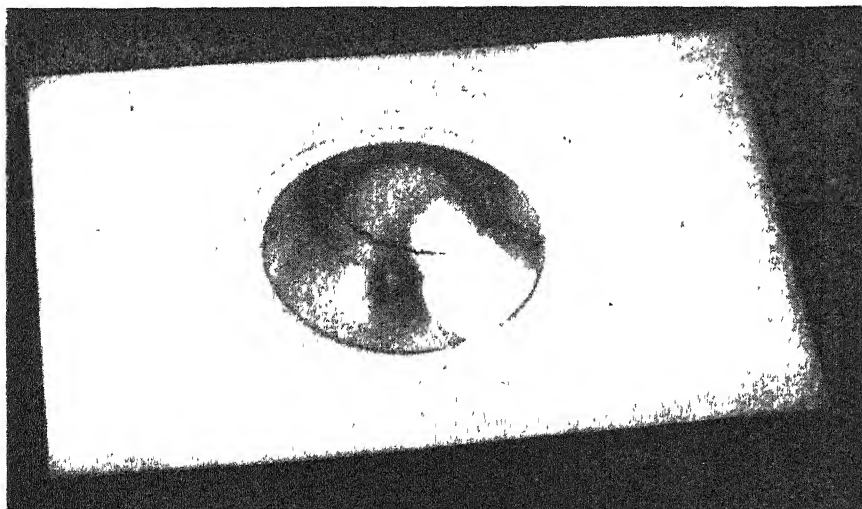
Tea service of speculum-plated pewter. Not as blue as chromium, speculum has luster of silver but tarnishes less and resists food discolorations better

ing between 25 and 40 percent tin. Small cast speculum mirrors are still used for a variety of optical instruments because of their brilliant luster, but their relative brittleness in the cast form has restricted their general use. The modern electroplated speculum, which serves in the form of a brilliant coating on a ductile base material—for example, steel—overcomes this earlier limitation of brittleness.

The process of electrodepositing the alloy has roots both in the United States and in England. In 1931 a patent was obtained in the



Ductile, speculum adheres well to most base metals. Steel fork (above), bent after plating, shows no flaking of the speculum coating. In cupping test (left) base broke, speculum adhered



United States by H. M. Batten for a process that has since been used for the production of electrodeposited "red bronzes"—copper alloys with from 2 to 10 percent tin. The successful development of speculum plating baths, according to the Tin Research Institute, was more closely bound up with the art of plating pure tin from alkaline solutions, to which many workers have contributed.

HOW DEPOSITED—The speculum plating bath now in use plates out tin and copper simultaneously to give a true alloy of controllable composition. The bath contains tin as sodium stannate and copper as cyanide, with free sodium cyanide and caustic soda also present. Because small variations in the composition of the coating are not critical and because of the nature of the bath, the process is relatively easy to operate. Sound chemical control is necessary to maintain the correct conditions of deposition—such control is required in all high-quality metal-plating—but the procedures are simple and well within the capacity of the normal plating shop laboratory. Cyanide and caustic soda contents have to be checked every two or three days, tin and copper every two or three weeks.

Because of the high corrosion resistance of speculum, it is not possible to use alloy anodes. Replenishment of the metal content of the electrolyte is obtained by using separate tin and copper anodes; the electrical circuit to the two anodes is split and each circuit is provided with separate means for individually adjusting the current. The copper anodes are operated under conditions similar to those in cyanide copper plating and the tin anodes are operated as in stannate plating of pure tin.

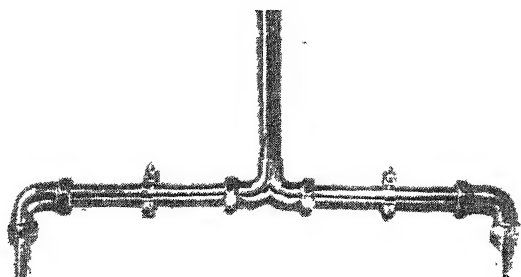
"ONE COAT" — Chief among the production advantages of speculum plating is that it is a "one-coat" finish, no undercoat being required. The bath has exceptionally good throwing power; depending on the base metal and the amount of protection or service life required, plating thicknesses usually applied lie between 0.0005 and 0.001 inch. The most important labor charges associated with the process are the time required for preparatory polishing and in final burnishing, and even here it is reported that less preparation is needed for speculum than for nickel-plus-chromium coatings. Indeed, the Tin Research Institute cites cases in which satisfactory finishes were obtained on

stampings and spinings right off the machines, and others—cast brass faucets, for example—in which the labor for polishing before plating was approximately halved over other coating requirements.

Speculum coatings may be applied directly to steel, iron, tinplate, nickel-silver, copper, brass, bronze, silver, nickel, pewter, and so on. The coating itself is ductile and will withstand a reasonable amount of deformation without flaking or spalling. In color it is very much like polished silver, being less blue than chromium and less yellow than nickel.

Tests made on speculum coatings to compare their tarnish resistance with that of other metals or coatings showed that after 30 days' exposure to ordinary kitchen and living room atmospheres speculum coatings had lost none of their brilliance or reflectivity, whereas silver fell off more than 50 percent in the living room and 80 percent in the kitchen. Even under the worst conditions of test, speculum needed no cleaning at the end of a month. Whenever it is necessary to clean speculum, no metal polish need be used; washing with water and wiping with a soft cloth when dry are usually sufficient. The metal is not affected by the sulfur from eggs nor by lemon or tomato juice.

WIDE USES—From the prospective user's point of view, the warm color of speculum is often more attractive than the slightly bluish tint of chromium; where used for interior metal trim, it should permit a wider choice of decorative color schemes. For jewelry or tableware it is as attractive as silver and has the merit of not requiring frequent polishing. Speculum plated spoons and forks have been in use for several years



Speculum-plated lavatory piping. Economy of its application makes this copper-tin alloy attractive for quantity use on plumbing fixtures

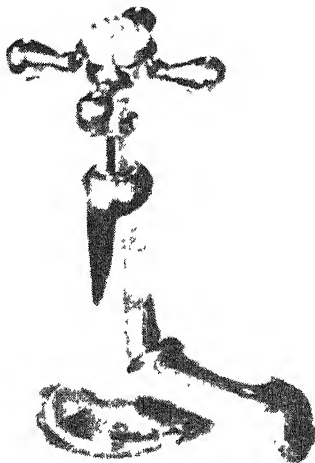
in some British homes and hotels and have remained perfectly bright with only the usual washing, while the coating, because of its hardness, has shown satisfactory resistance to mechanical damage

Speculum coatings have also been highly successful for bathroom and plumbing fixtures. Wash basins fitted with speculum-plated faucets have been in constant use for six years and are still in perfect condition.

On the other hand, speculum cannot as yet be recommended for outdoor use or, for example, as ornamental trim on automobiles. The reason for the much better tarnish resistance of speculum in inside atmospheres as compared to its luster-retention outdoors is not yet clear, and may be a physical rather than a chemical phenomenon. At any rate the situation is currently the subject of technical research.

On the face of it, the cost aspects of speculum seem very attractive. The intrinsic cost of the metals used compares favorably with those of the other decorative metals or coatings in common use; it is, of course, much cheaper than some of them. Then, as only one plating operation is involved, equipment cost, space charges, and labor time are lower.

For these reasons, and especially because speculum provides a brilliant, long-lasting, easy-to-maintain finish at base-metal prices, increasing interest in its use is evident. With it, cheap tableware can be given as beautiful a finish as with



Service testing, on such articles as faucets, proved speculum's durability

silver. Speculum has already been used in plating electric lamps and fittings, cigarette cases and lighters, ash trays, brass ornaments, dressing table accessories, and—as already mentioned—bathroom fixtures. Service trials are now underway on speculum-plated cooking utensils, jewelry, golf clubs, bird cages, and even baby carriage parts.

Speculum pilot plants have been in operation for some years in England. When tin again becomes plentiful it looks as though the tin industry may have a new major market and manufacturers—here as well as abroad—will have a new type of decorative metal finish.

ucts has been obtainable only through the use of extremely high (and therefore expensive) pressures or with additional coining and repressing operations.

Another novel feature of these cemented steels is their self-brazing nature. Because of the copper they carry with them at all times, parts made of Sinteel G may be readily copper-brazed to each other or to other materials without the addition of external brazing alloy or flux. Very large or complicated parts, not normally producible by powder-metallurgy methods, may thus be made by pressing simple or small components out of iron or steel powder, assembling them properly and then infiltrating the assembly with copper to give a uniform-impregnated and firmly brazed product.

Sinteel G, developed by American Electro Metal Company, is expected to find use for making large or complex parts or those requiring exceptionally high strengths that cannot be made economically by conventional methods.

AGE-HARDENING

Stainless Steel Combines Desirable Properties

THE COMPOSITION and physical properties of the United States Steel Corporation's precipitation-hardening stainless steel, which have been the subject of metallurgic conjecture for several months, were disclosed at the recent annual meeting of the American Institute of Mining and Metallurgical Engineers. The steel is of widespread interest because it provides a combination of high strength and excellent corrosion resistance without the necessity of cold-working the material for that purpose.

The composition of the new steel, called "Stainless W," is nominally 17 percent chromium, 7 nickel, 0.07 carbon, 0.70 titanium and 0.20 aluminum. By suitable age-hardening heat treatments—for example, heating to 1700 to 2000 degrees Fahrenheit, quenching, and then aging at 950 degrees Fahrenheit—tensile strengths above 200,000 pounds per square inch and hardnesses up to 47 Rockwell C can be obtained. Titanium is the most important single element in the age-hardening mechanism.

Many applications are foreseen for the new age-hardening stainless steel, especially in bar form, for such products as cams and rollers in food handling and bottling equipment, and bearing and valve parts in the petroleum, chemical, and related industries.

DUPLEX METAL

Produced by New Powder-Metallurgy Technique

AMOUNTING to a new type of metallic material, "Sinteel G" combines steel and copper in an unusual way.

Sinteel G is made by pressing iron or steel powder to form a porous briquette and then impregnating the pore structure with copper by immersing the briquette in a bath of molten copper alloy. The resulting product is dense—virtually pore-free—and, depending on the raw materials and subsequent heat treatments employed, may have tensile

strengths ranging from 50,000 to 175,000 pounds per square inch. The latter figure is one of the highest ever reported for an essentially ferrous powder-metallurgy product. Because of its structure, the material is readily machinable and electro-platable.

From the standpoint of the powder-metallurgy fabricator, these "cemented steels" are especially interesting because their high strengths are obtained with low pressing pressures (20 to 45 tons per square inch) and without a coining operation, whereas heretofore such high strength in powder-metallurgy prod-

Sell, Then Buy

Specialists, Familiar with All Phases of a Particular Process, and Fabricators, who Assemble and Sell, but are Not Manufacturers, are Supplementary Figures in Modern Industry. Interdependency, Mark of a Complex Civilization, Can Bring Better Products at Lower Cost

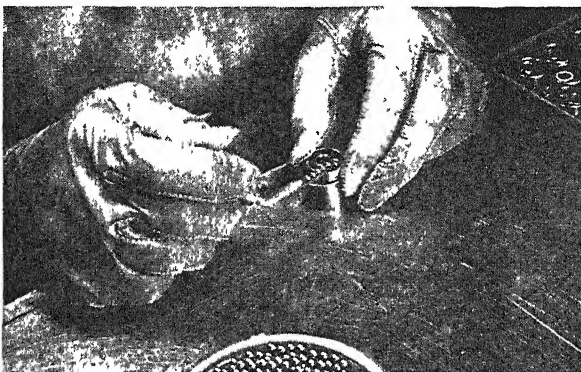
By EDWIN LAIRD CADY

BACK in the early 1930s, an old-time manufacturer of wood-working machinery was holding a management conference. The president, definitely of the old school, was pounding the table.

"Ya can always sell what ya ain't got," he said. Then, glaring at the sales manager and the purchasing agent who were opposing him, he added: "Never mind this stuff about buyin' cut gears on the outside. We've got a foundry and we're goin' to run it. What we want is a sales department that can sell the cast tooth gears, same as we always sold."

What this president was arguing was that manufacturing company profits must come from the operation of that company's own machinery.

What the sales manager and the purchasing agent were arguing was that business profits can come from the turn-over of operating capital no matter how this is achieved. They did not think in terms of any such



Ball bearings are used in many products, but the art of their manufacture is concentrated in a few companies who supply, on order, either standard or special bearings

economic philosophy, of course. All they had on their minds at the minute was to get some cut-tooth gears which would run more smoothly, and make less noise, and be more satisfactory to the customers than the old cast-tooth gears. But they were working toward the modern art of sub-contracting which could be defined as "the art of making money by selling what you haven't got."

The lengths to which old-time manufacturers went in order to make everything themselves and "save the other fellow's profit" would amaze any modern management. They even went so far as to compound all their own cutting oils out of lard oil and similar raw ingredients, put in electro-plating departments which would function only one week out of every month, design and produce special electric motors for their machine tools.

NEW CONCEPTS — Modern management thinks the opposite way. It will not tool up to make anything until it has first made sure that it cannot buy that product from someone else to better advantage. There is too much competition for the services of every dollar available for investment. The same money which would go into an increase in

the size of the gray-iron foundry might better be used to install an induction heat-treating set up, put on a more powerful advertising campaign, or open a Sacramento branch plant to manufacture goods for the west coast.

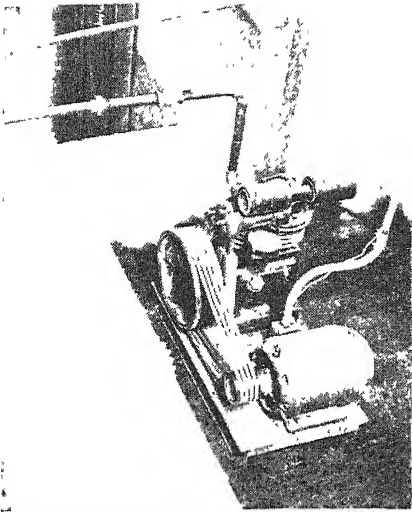
One result of this new philosophy is a host of brand new or greatly improved production methods. Specialists in various processes, learning that they could depend upon getting business from thousands of manufacturers, have been encouraged to develop their techniques and equipment to the point where they can produce at such low costs that it hardly pays a manufacturer who might buy from them to install his own production line.

The wood-working machinery company management which was arguing about whether to buy cut gears or continue to use its own cast-tooth products, could easily have installed equipment for cutting its own gears and obtained everything that a professional gear-cutting shop could offer. Tooth forms were simple and gear materials were few. Testing methods would have been confined to running pairs of the gears together to show up undue noises.

Today, that is no longer true; tooth forms can run all the way

● LOOKING AHEAD ●

Advances in the technology of most industries are so rapid in these times, that even those who manage to keep abreast of their own field must fall behind in others directly related. . . Add to this the cost of special machinery and trained personnel, and the worth of the specialized sub-contractor becomes apparent. . . This situation will continue with the almost geometrical growth of new techniques and their application to formerly slow-to-change products. . . Engineering, once confined to smoke-filled drafting rooms, will more completely take over the purchasing office.



Courtesy The Louis Allis Company

Simple air compressor is product of a complex economy. Motor, motor-control, belting, small fittings, and stampings represent specialized builders

from the simple involute spur gears to the various helicals, herringbones, hypoids, and others. Teeth can be ground for high dimensional accuracies, shaved for surface super-finishing to accuracies as close as one millionth of an inch, or burnished for long wearing qualities. Materials can include ordinary gray irons for low cost, steel forgings for toughness, heat-treated steels for high strength and hardness, fabric-reinforced plastics for silence, and many others. Inspections can be by micrometer-movement instruments, by shadographs, by electronic devices, and even by automatic X-ray equipment. Just to list the resources of a modern gear shop would take a thick catalog. To get what a well equipped maker of gears would offer, the wood-working machinery maker would have to invest hundreds of thousands of dollars in special equipment.

The gears might not even be made in a gear shop. They could be produced by a powder-metallurgy plant, in a precision investment-castings plant, on a press-forging production line, or by any of several other methods.

PURCHASE ENGINEERING — With all of these opportunities open, the modern management conference on how to produce a new design or new line has as much of purchasing as of manufacturing in its discussions.

The first step, of course, is working out the original design. And here is an abrupt break with old-line thinking. The old-timer would have told his engineers: "Don't design it unless you are sure we can make it." The modern manager is more likely to say: "Go ahead and work it out, we are almost certain to

find someone who can make it."

After that comes a dividing of the parts or of the complete mechanisms which are to be bought outside from those to be made in the plant. A present-day engineer, for example, who planned on designing his own special electric motors and making them in his own plant, would have to have a highly unusual reason for doing so. But some of the gears might be made in the plant; others might be purchased outside; and still another group might be so specified that their holes were bored and their teeth cut in an outside contracting plant, but special facing or threading operations on them performed in the home plant.

A new machine might need several types of stampings or forgings, some to be made to high accuracies and of stainless steels, and others to ordinary accuracies and of common steels. The high accuracy stainless-steel parts might be ordered from an outside contractor, the ordinary ones made in the plant.

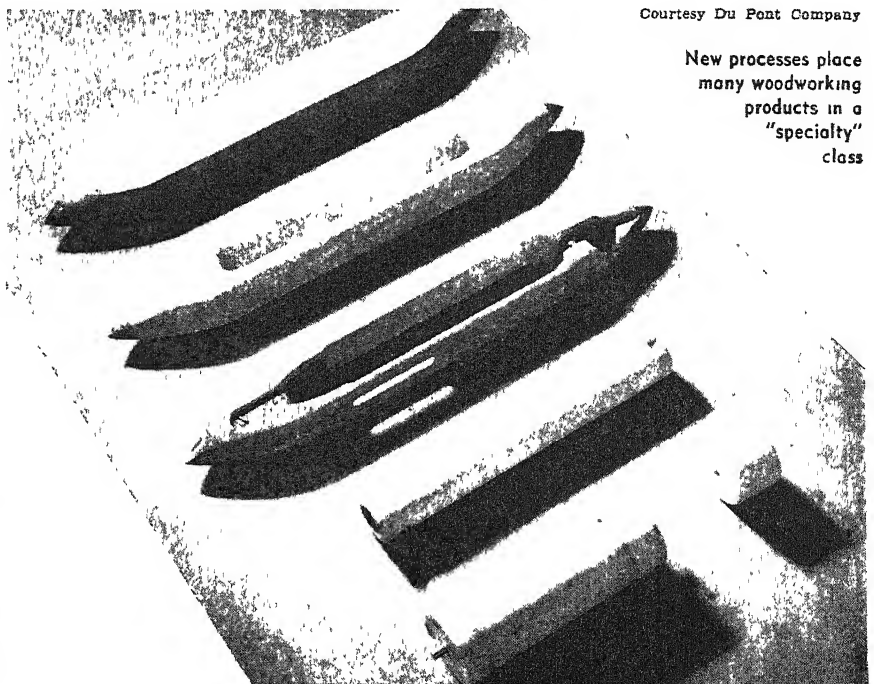
All of this requires an engineering skill in purchasing which is a far cry from the days when the purchasing department was a mere checker of prices and placer of orders. But it pays dividends.

One purchasing agent had the engineering staff make a careful study of the possibilities of precision investment castings for their company's products. The first thing discovered was that the company would need at least \$25,000 of capital outlay and a year of experimental time to get its own precision investment department into operation. This would not be worth while. But by dealing with outside contractors,

three of the present parts could be cast integrally and made into one. The present methods call for two small stampings and one screw-machine product which are brazed together. The new method produces the whole assembly for less than the costs of its three members and eliminates two brazing operations as well.

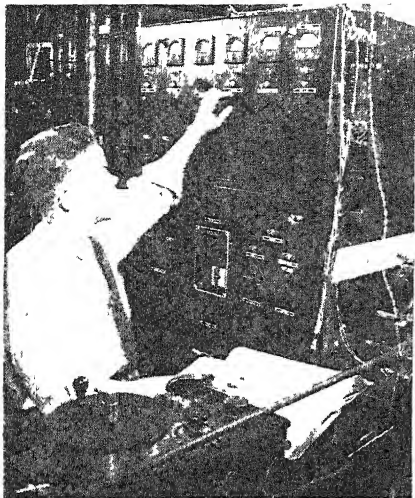
NEW PROCESSES — Open to such purchasing agents are a large number of brand new processes and of old ones which are so vastly improved that they might well be classed as new. To mention a few which apply to small parts alone: Centrifugal casting, die casting, swaging, cold heading, plaster-mold casting, permanent-mold casting, press forging, upset forging, impact extruding, plastics molding. By merely adding to these and listing their variants, any good purchasing engineer could set down enough purchasing opportunities to fill an engineering directory.

An example is the purchasing agent who brought into his plant operations which previously had been bought on contract from outside companies. He was employed by an airplane company which was changing its models so constantly that parts had to be ordered in rather small lots. Here a problem arose on parts fabricated by stretch-pressing and other mild forming methods. The tool and die charges were high, the purchasing agent constantly had to send out new blue prints and wait for quotations, and when the first shipments of new parts arrived their designs often had to be modified to conform with



Courtesy Du Pont Company

New processes place many woodworking products in a "specialty" class



Westinghouse photograph

Extensive research equipment and skilled technicians make "outside" contractors "wise" in the ways of producing items needed by industry

further changes in the plane models

Then, the agent had the purchase engineers study the cast thermosetting phenolic resin plastics which have sufficient structural strengths for some tool purposes. These can be cast to shape in wood, plaster, or metal molds which have been coated with a special lacquer to facilitate removal. By including an accelerator in the mixture of phenolic resins, dies good enough for short production runs could be made in only 12 hours of plastics setting time. By eliminating the accelerator and taking 96 hours of setting time, tools having the necessary structural strength and fatigue resistance for fairly long production runs could be produced. The making of the necessary molds was a simple process once the mock ups of the parts were completed.

The plant, then, could have the tools for turning out short production runs within 24 hours after completing the parts mock ups, and tools for longer runs could be ready in a week. Later on, decision could be made as to whether to continue making the parts with those same tools, or with more durable steel tools, or to have them made outside and free the production line for further short-run work.

SPECIALIZATION — While all this has been going on in plants which use metal parts and mechanisms, other industries have not stood still.

The textile industry has spent the past 40 years learning to specialize. There are some large and self-contained mills; plants that are sufficient to themselves still exist in nearly every industry. But more and more the weavers of textiles tend to obtain their fibers from one producer and send their materials

to professional dye houses to be dyed in the skein or in the piece. Many mills do nothing but weave, getting their bobbins ready-wound and their warps ready-filled, choosing their fibers and colors in accordance with the materials and colors they can sell. And the higher the prices and qualities of finished fabrics the more likely they are to be the products of chains of specialists who run their individual plants but serve one another.

Woodworking is following a similar path. For a long time the only raw material of this trade was raw lumber, and every plant was a more or less direct competitor of every other. Now, with the new wood preparation processes—transmitted, stabilized, and hydrolized wood—there is plenty of room for specialization and its consequent subcontracting.

One large fabricator of wooden products already has a crew of purchasing engineers in the field and is training more. The job of these men is to go to the smaller plants, teach them the new techniques, get them to make the specially processed raw materials and even the semi-finished and the finished products which the

fabricator can sell. The use of new quick and sure-setting cements to make laminates of various woods and of woods and metals, glasses, plastics, and synthetic rubbers is one of the arts which these engineers will teach. They will be aided by sales engineers of the cement and the equipment making companies which want to sell to these processors. But the main objective of the fabricators is to add the flexibility of having widely diversified sources of supply from which to buy specially processed raw materials which he can fabricate and sell.

This trend toward buying products rather than insisting upon manufacturing them has one meaning that often is overlooked. A good description of "civilization" would be: "That state of society in which men can depend upon each other instead of having to depend upon themselves alone." And when manufacturers base their profits upon wide-spread purchasing of finished products in open markets rather than solely upon what they can make in their own plants, it means that industry is assuming a state of civilization.

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MOBILE CARRIERS

*Give New Flexibility
To Industrial Operations*

TAKING advantage of the extreme advances in the design of gasoline engines, Diesels, and electric motors which were made during the war, the development of mobile carriers for all sorts of repair and maintenance and even of production equipment promises to be one of the most interesting phases of engineering for the next few years.

One type of equipment embodies welding generators, hoists, and other positioning equipment for parts to be welded, and a small air compressor to supply pneumatic power for welding clamps and for chipping hammers.

Another type has a closing and stapling unit for boxes which can be run to any point on a packaging line and operated there. It is an adaptation of existing stationery equipment with a small Diesel to supply the power. Its use makes the shipping line far more flexible, permits freight cars to be spotted for loading with more of the platform spots available to take-offs or branches from the main gravity conveyor, and permits pallet loading to be carried on at enough stations along the production line so the line need

never be stalled if the lift trucks do not arrive rapidly enough to keep the stapling machine free of filled boxes.

These two uses show extremes of adaptations for mobile carriers. And with the new engines and motors their development has just begun.

SUPER-HARD METALS

*Now Find Wider Use
in Familiar Articles*

EXTREMELY hard metal surfaces that can be welded, brazed, or mechanically fastened to softer metal parts to prevent wear are finding new uses every day. One of the latest is as edges on snips used for cutting wire screening, aluminum sheets, and other metals which quickly dull the softer steel edges that are used for cutting tin plate. Another use is in nozzle tips to handle liquids in everything from fog-spray fire fighting apparatus to cotton and other farm sprayers. Only a few years ago these extra-hard metals were regarded as high-cost and temperamental products to be used only in high-capacity high-precision metals cutting equipment. Now they are to be found quite frequently in the "common" or "garden" varieties of equipment that everyone uses.

Petroleum Process Products

From about Two Percent of the Crude Oil Produced Comes a Myriad of Little-Known Materials that Aid—In Proportions Far Exceeding Their Quantity—in the Production of Nearly Everything We Use, Eat, or Wear, Emulsified Waxes and Textile Oils Have Major Importance, Wide Use

By JOHN C. DEAN

Technical Division, Process Products,
Socony-Vacuum Oil Company, Inc.

THE SCOPE of petroleum's utility as a processing material is virtually unlimited. At present, over 30 basic industries employ petroleum in their manufacturing processes, and the individual applications are numbered in the thousands. Some conception of this use of petroleum, both as a processing material and as a source of organic chemical compounds, may be gained from statements that point out the possibility of more than a million such materials and compounds that have petroleum and natural gas as a starting point. This compares with about 500,000 derivatives from coal tar, long considered a chemist's treasure trove.

It is also interesting that a very small portion of the crude oil total is required for producing process materials. Fuels, lubricants, and greases—the petroleum industry's standbys—account for about 98 percent of the total output of the wells. Yet, the remaining 2 percent looms significantly large in terms of both financial and human values. For example, it is impossible to set a monetary price upon the accomplishments of the minute quantities of petroleum derivatives that are used in life-saving medicines. Neither can the values of the process products that contribute so much to ultimate consumer satisfaction be reckoned entirely in terms of financial return to the petroleum refiners.

WAX EMULSIONS — A typical petroleum process product is found in wax emulsions. Here a multitude of industries—textiles, paper, food, wood, and so on—profit from a tiny segment of the petroleum chemist's research.

Most of the familiar uses for petro-

• LOOKING AHEAD •

More and more petroleum refiners are setting up laboratories to study industry's processing problems. . . And more and more specialized products are being produced to eliminate these problems. . . Industrial-refiner co-operation is often necessary to establish the facts. . . The final process product, as exemplified by textile oils, is compounded to do a precise job. . . The high costs of makeshifts vanish, and a competitive edge and better merchandise accrue to the manufacturer who searches scientifically for processing materials.

leum waxes have been as "hot melt coatings"—that is, wax applied in a molten condition. There are, however, other methods of applying waxes, one of the most effective of which is in the form of an emulsion. These "wax emulsions" are suspensions of wax in water, stabilized with suitable emulsifiers and dispersing agents. Wax emulsions look like milk, and in fact are quite similar in general composition to milk, which is essentially a suspension of butter fat in water stabilized with casein. The wax particles of an emulsion are similar to the droplets of butter fat, and the emulsifiers are comparable in action to the casein.

One of the advantages of a wax emulsion is that it permits small quantities of wax to be applied in controlled amounts. This control is also possible with solutions of wax, but with emulsions, no costly solvent-recovery units are needed; the vehicle (water) is non-toxic and

non-flammable, and the application can be effected at very low cost and with readily available equipment.

An easily visualized and important use of wax emulsions is the treatment of textiles to impart a water-repellent finish. This is accomplished by running the textile cloth through a wax emulsion bath in which it picks up some of the emulsion. Upon drying, small amounts of wax—generally between 1 and 4 percent—become deposited on the individual fibers and render them resistant to water. The cloth then has water-shed properties. This treatment has practically no effect upon the appearance of the cloth or upon its feel or "hand." Furthermore, because of the openings which remain between the fibers, adequate ventilation is provided when the material is used for clothing. If the fabric were water-proofed by a hot-melt coating, however, it would be stiff and board-like. The armed forces purchased millions of yards of fabrics treated with wax emulsions for use as tent cloth, drills, cotton duck, and mosquito netting.

PAPER TREATMENT — A second extremely important use of wax emulsions is in the manufacture of paper, where once again small quantities of wax are capable of imparting water-resistance. Two methods are used for introducing the wax into the paper; one prior to the formation of the sheet, and the other as a treatment of finished paper. The former method is known as beater-sizing, and involves adding wax emulsion to the pulp while it is being beaten. By this method the microscopic wax particles of the emulsion are deposited uniformly on the paper fibers and give each

fiber a degree of water-repellency.

The other method of paper treatment is known as surface-sizing or top-sizing, and is accomplished by passing a finished sheet of paper through a bath of emulsion in substantially the same manner as in the treatment of textiles. With either method, wax emulsions improve the water-resistance of paper, enhance resistance to scuffing, provide better printability, and yield a smoother, more attractive sheet. The effectiveness of less than 1 percent of wax in these applications is truly remarkable.

USEFUL WAXES—Most petroleum-wax emulsions were originally developed for the treatment of textiles and paper, but they have proved to be so versatile that a number of other interesting uses for them have been found. For example, a wax emulsion is now being used for the treatment of white potatoes to improve storing properties. Clean potatoes are dipped in a diluted emul-



Small homogenizer for preparing wax emulsions uses 5000-pound pressures

sion and are then dried to deposit small amounts of wax on their surfaces. In actual practice, one gallon of emulsion will treat between 30 and 40 bushels of potatoes, which will then remain fresher, last longer, and show much less loss in weight during storage. In addition, wax emulsions have been found to be effective for the treatment of cut potato seed before it is planted. Here it prevents rotting of the seed during wet weather and ensures a healthier stand of potato plants after germination and sprouting, so that increases in yield up to 15 percent have been reported in many instances.

The manufacture of certain

wooden articles, such as bowling pins and shoe lasts, can be facilitated by a wax emulsion treatment of rough-cut blocks which are kiln-dried before being turned down to finished articles. These blocks are generally cut from green lumber, which, if allowed to dry with no treatment, would develop cracks or checks that penetrate far into the wood. This splitting is caused by in-



Life of sole leather is upped about 25 percent by processing with special oil. Abraser in foreground tests soles

ternal stresses and strains that are set up in the blocks because of non-uniform loss of moisture. The thin film of wax which is deposited promotes uniform drying and practically eliminates the destructive internal stresses.

During recent years, many ceramic pieces, particularly steatite parts for radio and radar equipment, have been manufactured by automatic high-pressure extrusion. The body mixes are generally molded in a nearly bone-dry condition, and therefore require an agent to permit plastic flow, as well as a binder to maintain rigidity in the pressed pieces. An emulsion of a microcrystalline wax, especially selected because of its toughness and adhesiveness, has been found extremely well suited for this work. Many of these steatite parts and such other ceramics as porcelain and chinaware are finished with a glaze, in which another wax emulsion has been found to be effective as a binder. In these applications, replacement of starches and natural gums with waxes speeds production and produces more uniform glaze coatings.

The list of other uses of wax emulsions is long; a few are the



Photographs courtesy Socony-Vacuum

Testing a wax-emulsion-treated fabric for water repellency. Cloth remains porous, but water runs off its surface

polishing of clothes pins, treatment of nursery stock during transplanting, water-proofing of burial vaults, and as an additive for starch in laundries

TEXTILE OILS—Wax emulsions illustrate the fact that certain basic petroleum products must be compounded to render them useful. A second field of activity where such compounded products are widely used is in the manufacture of textiles. The textile field is broad and includes woolen and worsted fabrics, cottons, rayons, and cordage fibers, all of which are treated with petroleum oils of one type or another.

In the processing of woolens and worsteds, it is necessary that the fibers be lubricated to prevent breakage during the combing, spinning, and weaving operations to which they are subjected. Wool, as it is sheared from the sheep, is covered with wool grease, but this fat is lost when the raw wool is scoured to clean it of dirt. Therefore, nature's lubricant must be replaced before the clean wool can be handled further. When fatty oils are used in processing, they are applied as crude emulsions made by adding them to warm solutions of caustic and alkali. A more modern method uses self-emulsifying petroleum oils, which produce highly stable emulsions when added to water.

Mineral oils have several advantages in this use. They do not become rancid with age, as do some fatty oils, and therefore cannot become spontaneously ignited as in extreme cases of autoxidation. In addition, petroleum products provide better lubrication of the fibers because fewer fibers are broken during processing. The result is the formation of a stronger yarn.

After the lubricated woolen fibers have been processed into woven

cloth, the lubricant has carried out its appointed task, and must be removed. This is accomplished in the "fulling and scouring" operations in which the cloth is wet with a concentrated solution of soap and alkali and subjected to a pounding which causes it to shrink. This shrinkage in length and width renders the cloth thicker, or fuller; hence the term "fulling." When fulling to the proper degree, the cloth is scoured or rinsed by passage through a succession of warm- and cold-water baths during which the dirt, alkali, soap, and oil are removed simultaneously. The finished wool, originally oiled with 3 to 10 percent of lubricant, emerges with its oil content reduced to 0.5 percent or less.

SIZING—In the case of cotton goods, petroleum is used largely in finishing or sizing operations where fillers and softening oils are applied to the cloth to improve appearance and hand, and to increase weight or body. Sizing materials, such as starches and gums, are generally quite brittle, and therefore require a softening agent. In many instances, petroleum oils of various types and certain petroleum waxes can successfully perform this plasticizing action. Numerous types of sizing operations are employed with cotton goods—for example, the sizing of warp threads, heavy back fillings of book-binding cloth, and plain sizing of cotton dress fabrics and similar materials. In addition there are certain emulsifiable petroleum products that are used in the Sanforized process as softeners and as agents to improve the re-wetting properties of the cloth.

The rayon industry is a particularly large user of petroleum oils which are employed as lubricants for the rayon fibers. While only very small percentages of oil are applied, tremendous quantities of rayon are produced and the consumption is so large that the oils are usually purchased in tank-car quantities. A less important application in rayon processing is their use in soaking oils which serve as softeners for the gums and starches used in the manufacture of rayon crepes and rayon stockings. These mixtures are applied to the yarn before knitting or weaving to set the twist, but are washed out after these operations, thus releasing the fibers and permitting them to develop the characteristic texture of the fabric.

The processing of cordage fibers such as jute, sisal, and hemp also requires the use of large quantities of mineral oils, petrolatums, and waxes. They are employed as lubri-

cants, softeners, or water-proofing agents for the finished products in order to prolong their service life or to render them more useful for specific applications. Addition is most generally accomplished by direct applications to the fibers either prior to or during stranding operations.

Probably the outstanding feature of an examination of the petroleum-process-products field, is the apparent endlessness of applications. Nearly every phase of industrial endeavor, from the manufacture of synthetic rubber to the formulation of chewing gum and candy, call upon petroleum for sometimes minute—but usually vital—quantities of processing products.



ANTI-FOAM ADDITIVE

Improves Engine Lubrication at High Power Outputs

OIL FOAMING, a condition stemming from the violent mixing of air and vapor with lubricating oil under high-speed and elevated temperature conditions, has at times promised to hamper the wide usage of the most modern engine designs. In its worst form, foaming may cause engine failure, milder cases frequently impair lubrication and give rise to oil loss through breather passages and other engine openings. Now, the development of an anti-foam additive that reduces the surface tension of the oil and permits each individual bubble to break up on reaching the surface is said to



Additive-treated oil (right) does not foam when mixed with air. Same oil, if minus additive (left), foams vigorously

offer a material reduction of foaming troubles.

Previous attempts to limit foaming by means of mechanical traps and similar devices, while partially successful, complicated the lubrication system and did not correct the basic trouble source. Use of anti-foam additives, however, such as this one developed by Gulf Oil Corporation, may clear the way for more widespread use of the so-called "heavy duty" type engines.

THIOPHENE

Once Expensive, Will Alter Familiar Products

UNEXPLORED fields in chemistry—especially in the plastics, pharmaceutical, and dyestuffs industries—may be opened up as a result of a new and inexpensive method for producing thiophene from petroleum. Previously priced at \$54 a pound, too expensive for extensive use, thiophene can now be produced, according to Socony-Vacuum Oil Company, developers of the method, at a cost that is commercially practical.

A colorless liquid, thiophene is heavier than water and boils at 183 degrees, Fahrenheit. Its odor somewhat resembles that of benzene. Also, thiophene resembles benzene in its reactions, although different reaction conditions may be necessary. A large portion of the chemical industry is built around the chemistry of benzene. Dyes, pharmaceuticals, plastics, and a host of other chemical commodities to a large extent are derived from benzene and its compounds. Thiophene, therefore, permits the chemist to prepare many of these products which differ in that they will contain the thiophene ring in place of the conventional six-carbon-atom benzene ring. This fact presents numerous opportunities for altering such characteristics as the color of dyestuffs, the physiological effects of medicinals, and the hardness, elasticity, brittleness, and many other properties of plastics.

Under suitable reaction conditions, thiophene also reacts with aldehydes, to form thermosetting resins. In this respect, the behavior of thiophene may be likened to that of phenol, although there are important differences. Nevertheless, in the condensation of phenol with aldehydes, under suitable reaction conditions, it is possible to replace phenol with thiophene in any proportion.

The raw materials from which thiophene is made are plentiful and it is expected that production of commercial quantities will soon be under way.

Aviation Engineering Emerges

Boosting Cooling-Air Flow with the Energy of Hot Exhaust Gases; Means of Making True Automatic Flight Commercially Possible; and Many Other New Ideas were Food for Discussion at a Recent Aeronautical Engineer's Meeting. Aviation Research went Far During War Years

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

AVIATION'S war-time role was a large one, and while many accomplishments of both the industry and the planes and their crews have become legend, other activities have necessarily been carried on rather quietly because of their inherent nature. One of these comparatively unheralded activities was the work of the aeronautical design and research engineers. Now, with the tremendous pressure of war removed, many of the once-restricted research projects are being revealed and made public. Viewed in this light, the recent Annual Meeting of the Institute of Aeronautical Sciences opened a storehouse of data indicating the extent of aviation progress during the past several years and the manifold possi-

bilities of future aviation. It is, moreover, well to note that many devices and methods originally slanted at the sometimes demanding requirements of aviation are often worthy of adaptation to other industrial fields.

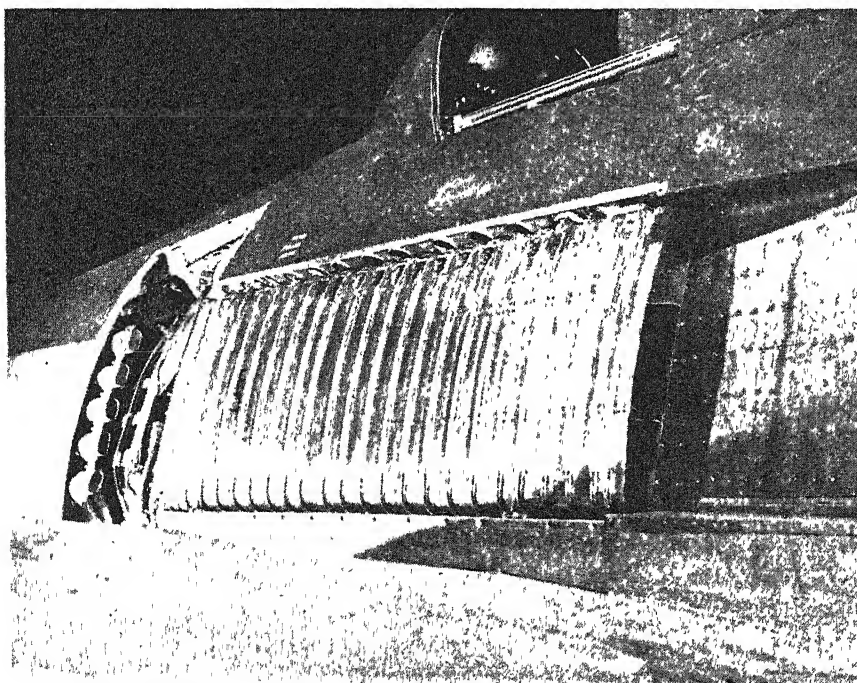
TELEMETER INSTRUMENTS — Radio, quite apart from its well known navigational and communications uses, has aided aeronautics—scientific and practical—in numerous ways only recently revealed. For instance, in aircraft instrumentation systems, it is frequently necessary or desirable to have indications of measured values at some distance from the point of measurement. This is a common need in flight-test work and is particularly important in ra-

● LOOKING AHEAD ●

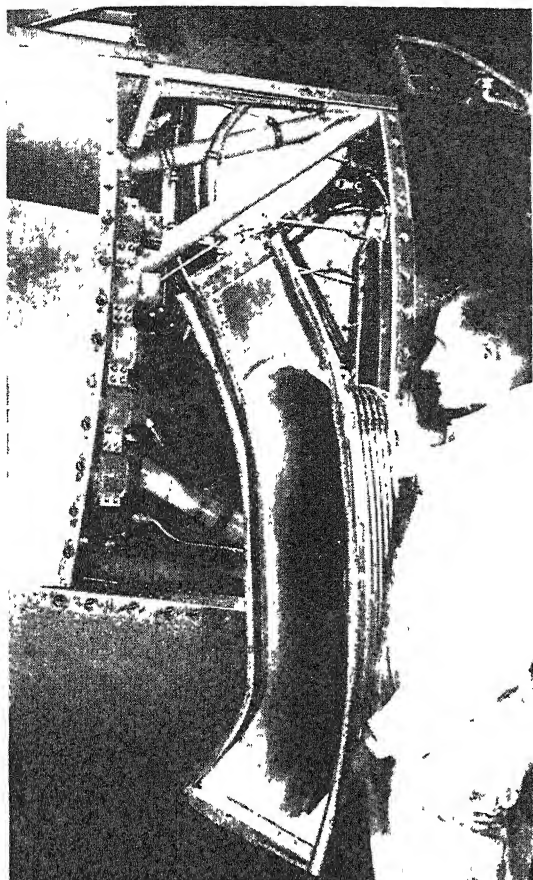
Aviation, involving nearly all the industrial sciences in one way or another, offers a fertile source of painstakingly obtained knowledge. As examples . . . the hydraulic motors that actuate so many aircraft controls must be unfailing, accurate, and rugged; qualities that make them potentially valuable to designers of machine tools and like equipment . . . dynamically similar models point the way to scientific but economical pre-prototype research for builders of a host of non-aeronautical devices concerned with critical dynamic forces . . . and instruments actuated by signals transmitted from a remote point of measurement may afford the laboratory worker and engineer an intimate picture of product performance in the field.

dio-control research where planes are sometimes flown unaccompanied by personnel

For such conditions, means of reading flight instruments on the ground were described by David William Moore, Jr. of Fairchild Camera and Instrument Company. Called "telemetry," the system permits remote reading of a standard aircraft instrument which has been slightly modified by the addition of a pick-up device magnetically coupled to the pointer. The pick-up does not hinder the normal functioning of the instrument since no friction is involved, and the only actual change in the instrument is the mounting of a small permanent magnet on the pointer hub. The transmission of the pointer position is brought about by a magnetism-sensitive element, mounted on the instrument face, and a radio-electronic system of some complexity. The theory of operation is based on the phase-angle relationship of the pointer, the output signal, and the receiving instrument on the ground.



Rear of exhaust-pump mixing ducts fit recess in fuselage; provide jet-thrust effect



Easily removed for servicing engine, fore-part of exhaust-pump mixing ducts must be carefully designed and formed in order to merge cooling air and exhaust gases at proper velocities for effective cooling. Mixing ducts are only exit for cooling air. Quintet of short tubes at left is exhaust stack portion of cooling system.

ered by two one and one half horsepower, two-cylinder gasoline engines weighing about three pounds each. The entire model, complete with engines, propellers, fuel, radio receiver, servo motors, and batteries, weighs 78 pounds as compared with 40,000 pounds for the full-scale plane. The operator's ground control station is essentially similar to the plane's actual flight deck and carries full scale controls. A 63-watt output transmitter transmits a single radio-frequency carrier wave modulated by seven audio frequencies which control the flaps, ailerons, rudder, elevator, two throttles, and ignition. The pilot's control wheel is equipped with a micro thumb switch which engages the auto-pilot.

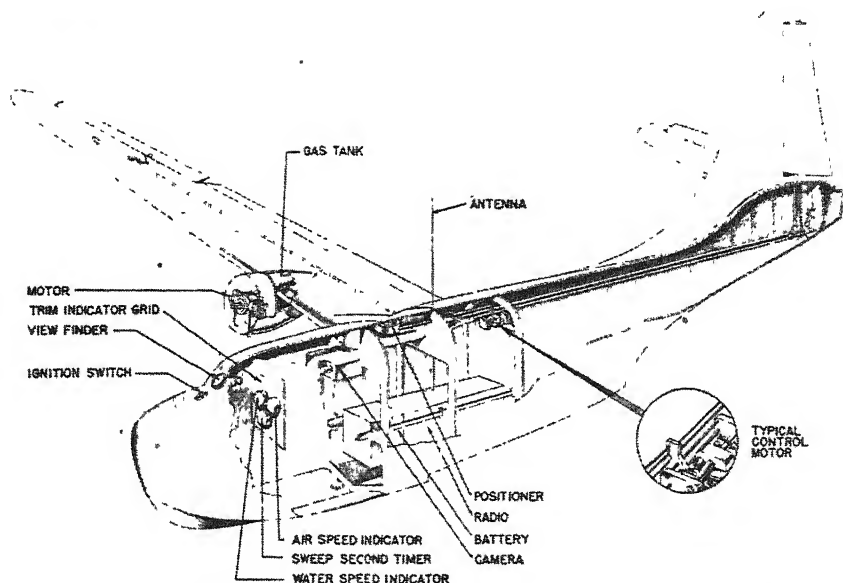
Thus, radio control, coupled with a movie camera and a special film analyzer as the recording portion of the team, now provides an accurate, relatively inexpensive, and thoroughly safe way to check preliminary aircraft designs.

HYDRAULIC MOTORS — Turning from general research to specific aircraft equipment, a paper by James Robinson of Vickers, Inc., discussed the hydraulic motors that

In operation, the pointer on the ground instrument moves in coordination with the pointer in the aircraft instrument.

Although originally designed for aviation purposes, it is now indicated that the telemeter principle can well be adapted for many industrial uses where remote indications of instrument readings are needed.

DYNAMIC SIMILARITY — Radio-control has not been confined to full-scale aircraft testing. Under the title, Precision Radio-Control of Dynamically Similar Flying Models, Ernest G. Stout of Consolidated Vultee Aircraft, explained the flight testing of seaplane and flying-boat models which were controlled by radio and provided with a movie camera to record the desired data. These dynamically similar models, originally developed for tow-basin testing, must be built with great attention to similarity of elastic characteristics and the mass must be distributed in the model in precisely the same way as in the full-scale machine. The complexity and expense of such construction is much greater than for geometrically similar wind-tunnel models. However, the non-flying, although dynamically similar types first used, were limited as a completely reliable source of design data because of tow-basin testing methods that required

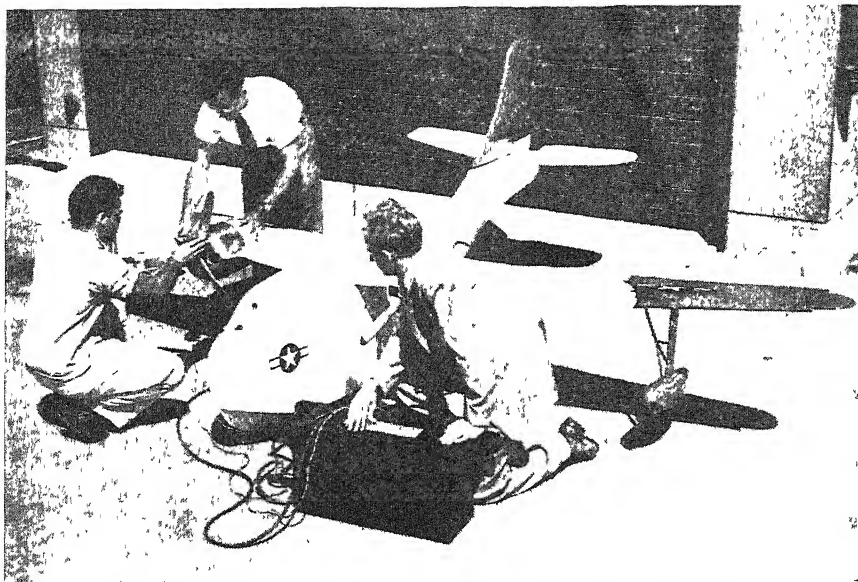


Complex controls in dynamically-similar models allow realistic test maneuvers

restraining as well as driving forces to be applied while the model traveled the half-mile length of the water-filled test basin. Consequently, radio-controlled flying models which can take off, land, exhibit stability or non-stability characteristics, and generally perform like the full-scale aircraft without restraint from test equipment, represent a genuine step in research progress.

One model of this type, a $\frac{1}{8}$ scale model of the Consolidated Vultee twin-engine flying boat, is pow-

found such extensive use in wartime aviation and now appear equally valuable for peace-time industrial applications. Basically simple and reliable, a hydraulic motor consists of little more than a cylinder, piston, and a pair of valves. Functionally these motors provide an efficient conversion of hydraulic power to rotary motion. As compared with electrical motors, hydraulic motors have greater acceleration and deceleration rates and improved reversibility; in fact, almost



Starting engines of 78-pound model; flight data will guide design of real plane

instantaneous reversal from full speed in one direction to full speed in the opposite direction is reported possible. The pressures used—in the 3000 pounds per square inch range—allow extremely compact and light designs. A hydraulic motor weighing only 6.5 pounds can deliver 15 horsepower. In addition, since hydraulic fluid is always present in the system, no special lubricant is necessary.

Aircraft uses for these powerful little units have been rather diversified. Hydraulic motors power gun turrets, wing flaps, landing gears, control surfaces, and even cable winches for air-sea rescue operations from helicopters. Adaptations in the non-aviation fields, however, promise to be equally extensive—particularly for actuation of such items as machine-tool controls and other automatic machinery.

ENGINE COOLING—As air-cooled engines increase in power and compactness, it becomes more and more difficult to cool them. Cooling air streams which are adequate for 400 or 500 horsepower engines, are inadequate for engines that develop 2000 or 3000 horsepower. This is, in part, due to the remarkable engineering progress that permits these latter powers to be obtained with very little increase in the frontal area exposed to the air stream. One remedy has been the installation of an engine-driven blower at the front of the engine so as to produce what might be termed a "forced draft." But, since the engine must devote a substantial amount of power to driving the blower, the improved cooling comes at the expense of a reduction in the over-all power available for thrust.

Now the exhaust pump, another

approach to the cooling problem, appears as a possible solution, and the main features of this device were reported in a paper, *The Exhaust Pump for Engine Cooling*, by Carl de Ganahl of Kaiser Cargo. Paradoxically, the exhaust pump is reported to improve cooling and, at the same time, yield an actual increase in thrust power. The cooling improvement stems from the use of the high velocity exhaust gases as a means of increasing the rate of cooling air flow over the engine. The pressure differential necessary to accomplish this is achieved by sealing the cowl, with the exception, of course, of the usual frontal-inlet area. Thus, cooling air is forced through one or more small mixing ducts extending from the rear of the engine to the after edge of the wing. Here, in the ducts, the cooling air is mixed with fast-moving exhaust gases in such a manner as to produce the two-fold advantage of accelerating cooling air flow and imparting additional thrust to the plane at the point of ejection.

These two major advantages of exhaust-pump cooling are supplemented by further gains such as more effective cooling during ground operation, and dampening of exhaust noises and flame. It was emphasized that design and construction must be properly engineered for successful use of this system.

Among other discussions at the meeting was one directed toward potential expansion of the uses of the electronic-type automatic pilot. It was suggested, for example, that interconnection of the pilot with the radio altimeter, blind-landing equipment, and radio and radar-homing devices, might soon provide an almost completely automatic means of piloting and navigating either mili-

tary or commercial aircraft. It was pointed out, however, that the inherent expense and weight of such a pilot would tend to rule it out as a private airplane unit.

Probably the most outstanding feature of the Institute of Aeronautical Sciences meeting was the great variety of active projects, ideas, and improvements represented. Certainly, it portends a healthy technical future for the aviation industry.

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AVIATION SURVEY

Is Issued by C. A. A.
In Pamphlet Form

THE AVIATION Information section of the Civil Aeronautics Administration has announced the issuance of a pamphlet entitled *Civil Aviation and the National Economy*. In it, exhaustive treatment of nearly every aspect of civil aviation is supplemented by many statistics; special emphasis is placed on the employment potentialities of the industry. Included in the booklet are many rather striking statements, among them: predictions of 400,000 civil airplanes for personal use by 1955; 2,600,000 families able to afford such planes, again by 1955; and estimates of about 1000 passenger and 200 cargo airplanes as representing the future equipment requirements for domestic and international air transport.

RUNWAY ILLUMINATION

Guides Planes in
With "Aisle of Light"

Two towering walls of light, on either side of a broad concrete runway, 8400 feet long are now being installed at New York City's new airport at Idlewild. This "aisle of light" together with radar and other blind landing equipment, promises to be a notable step towards making the airport an all-weather field, capable of handling an anticipated total of 900 flights per day.

The new landing guide will cause the pilot to see the runway as a dark area between twin "sheets" of controlled light that shoot upward without producing glare. Although the landing surface itself will be illuminated, surface brightness will be much lower than with present-day runway lighting. Each unit of the new system, installed by Westinghouse Electric Corporation, will include a 300-watt sealed-beam floodlight with a prismatic lens which will fan out light parallel to the runway.

Color To Order

Development of a Paint Mixing and Matching System Provides a Means of Producing, from a Minimum Number of Stock Colors and Vehicles or Extenders, Any Desired Color of Paint, for Exterior or Interior Use, and in Flat, Semi-Gloss, or High-Gloss Finish

A SIMPLE method of obtaining 1000 colors, tints, and shades is now offered by one segment of the paint industry as a means of alleviating a long-standing problem of the industrial or home interior decorator.

From time immemorial, these decorators have been plagued by the frequent necessity of accurately matching an existing color or providing a satisfactory complementary or contrasting color or tone in liquid paint. Results in the past have been obtained in one of two ways. The decorator or painter chose the nearest shade obtainable in standard ready-mixed paints, or he proceeded to approximate the desired results by combining available colors in a cut-and-try manner. Either the compromise was accepted—usually with undesirable mental reservations—or valuable man-hours were consumed in mixing pigments with little or no assurance that the final

• LOOKING AHEAD •

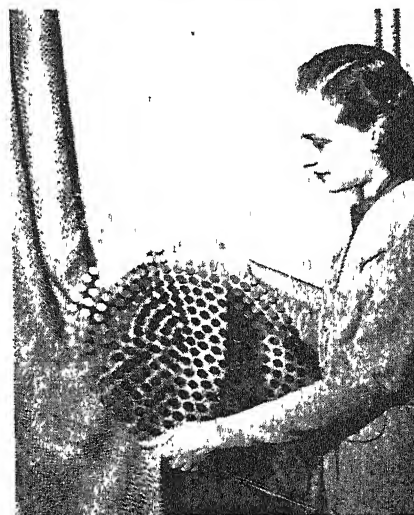
Paint stocks in dealer's stores can be greatly reduced yet customer's selection of desired colors can be expedited. . . Restrictions on available colors will no longer depend on ready-mixed paints that sell well. . . New system will be as helpful to small as to large dealers. . . Logical progression of available colors, tints, and shades should extend use of paint and give a greater appreciation of its possibilities.

product would dry to the shade desired.

Now, under a scientifically developed "custom-mixed" paint system, it becomes possible for the first time to select paint samples from a logically organized color directory and to have the exact paint shade

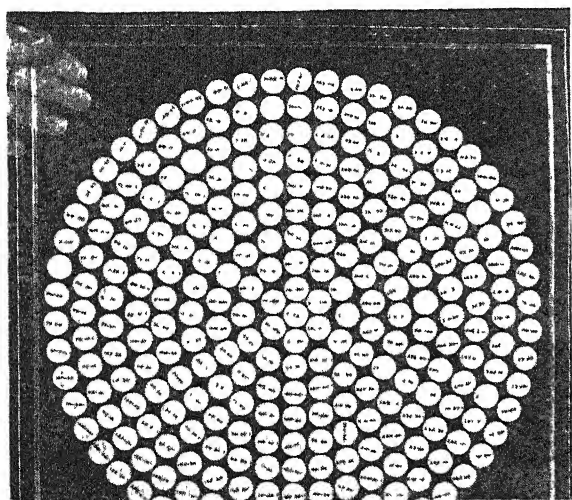
mixed from a standardized formula. In this way, it becomes possible to produce a color or tint which will match exactly any fabric, carpet, furniture, or office equipment, or to obtain colors which harmonize according to personal tastes or preferences. The time involved in producing these "custom-mixed" paints is a matter of mere minutes.

Basic to the new color system for paints, called Nu-Hue and developed by Carl Foss and Fred Rahr for the Martin Senour Company, is a group of six carefully chosen hues of yellow, red, orange, purple, blue, and green, plus neutral grey and



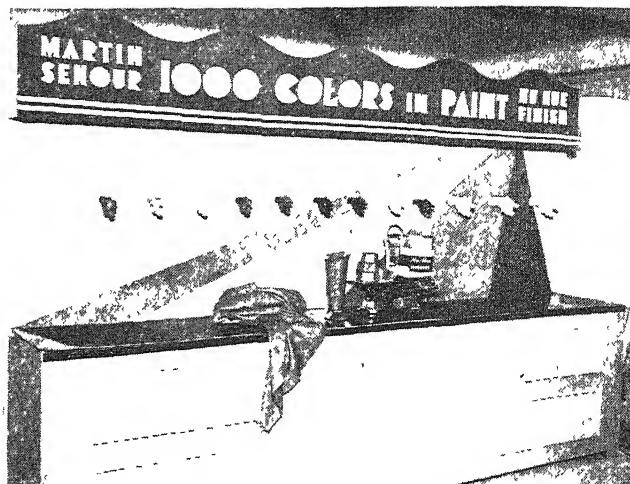
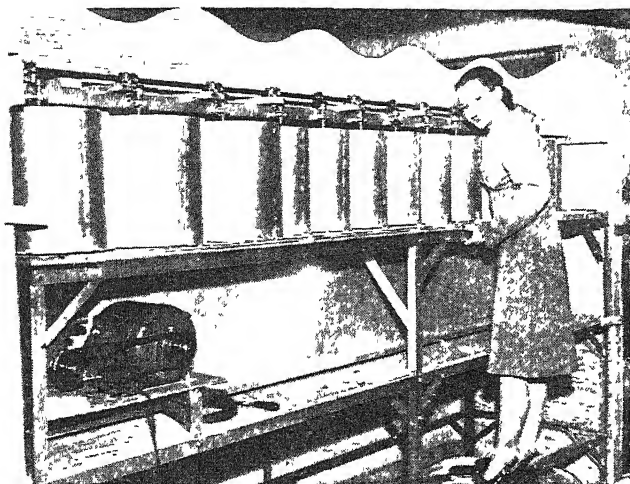
Code numbers on backs of color chips (left) identify paint formulas for selected hues and provide exact data for custom-mixing.

Above, right: Matching or complementing colors for drapes and room furnishings are readily chosen from paint chips mounted in plastics visualizers



white, plus a vehicle or extender, and a varnish if such an ingredient is required. The six colors have been developed for maximum purity of tone coupled with permanency. By combining one or more of these colors, according to a simple formula, with the grey and white, any one of the 1000 available paint tints, tones, and shades can be obtained with a high degree of accuracy. The formulas involved have been worked out to produce unvarying results after the paint is dry.

The six colors have been selected on the basis of what they will do when combined—not necessarily what they are when used alone. They are said to have a high degree of permanence for both interiors and



Front (right) and rear (left) of color dispenser to speed mixing of basic paints; motor driven agitators ensure pigment suspension

exteriors and can be used to produce a coating which will dry to any desired surface from flat through semi-gloss to high-gloss

The surface characteristics of the paint when dry are determined by the type of white used when mixed. Available to this system are the varnish previously mentioned, as well as three types of white, flat, semi-gloss, and high-gloss.

Thus the advantages of this new system lie in the fact that, with only twelve containers of material, any type of paint for interior or exterior work, and in any one of the 1000 shades and hues of color, can be obtained by following a specific formula and can be repeatedly produced as often as desired. This means less stock for the paint dealer and complete flexibility of choice for the buyer of paint.

Departing from the time-honored Munsell and Ostwald systems, which for many years have served color users as standard guides, the Nu-Hue system presents a well balanced gamut of the paint spectrum, proceeding in simple, logical steps, each visually related to one another.

The color directories used with the system contain actual paint color swatches or chips of the 1000 different colors, arranged in spectral order for easy selection. On the back of each chip is the formula by which the color on the face of the chip is made. Then it is simply a matter of measuring—by weight or by volume—the required amount of color, extender, grey, and white. When these are mixed together there is complete assurance that the desired shade will be achieved

For the painter, this means that there need be no wasted hours of experimentation in trying to match colors or tones. With a maximum of twelve cans of paint and with the formulas obtained from the color directory, the painter is equipped to produce any of a thousand colors



Basic paints in foreground offer the decorator the host of colors classified in the handy card-type deck directory

in the time that it takes to stir up any paint before using. For the paint dealer who handles a large volume of business, a simple dispenser for the colors and other materials has been designed. It is equipped with twelve containers, each feeding to a spigot. Motor driven paddles agitate the material in each of the containers to maintain perfect suspension of the solids. With such a dispenser any formula can be immediately compounded with a minimum of lost time.

So simple is the use of this new paint system that the most difficult formula requires the use of a maximum of two of the colors, plus extender, grey, and white. The formulas on the backs of the color chips are given in volumetric ratio, volumetric percentage, cubic centimeters per gallon, specific gravity, and grams per gallon. Thus the mixer can select any readily available method of measuring the required quantities.

In addition to the color directory there is also being made available a set of nine transparent plastics charts

with actual color chips embedded in them. These nine charts cover the whole range of 1000 tints, tones, and shades. Because of the transparency of the charts, they expedite color selection by permitting the user to view the material to be matched or complemented right through the clear plastics, thus placing the color chips in close juxtaposition to the material. A code number on the back of each chip gives the key to finding the formula for the color selection.

• • •

ENERGY FROM COAL

Defended Against Possibility of Industrial Atomic Energy

PREDICATING their conclusions on a price of \$15 a ton for coal, as stated in a question asked by Dr. James B. Conant, President of Harvard University, atomic energy experts recently predicted that atomic energy might economically come into competition with coal for industrial power production in from three to twenty-five years.

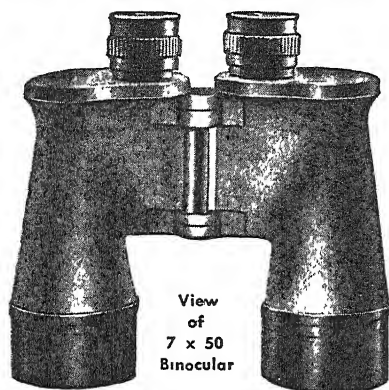
According to the Bituminous Coal Institute, this quoted price of \$15 is greatly excessive at today's market prices or on the basis of any prices which the industry has experienced. In the last 40 years the average price of bituminous coal at the mines has ranged from \$1.06 to \$3.75 a ton and is today approximately \$3 a ton.

Bituminous steam coal, which is the country's greatest source of power, is now being delivered to the power producers at a national average price of less than \$6 a ton. In several instances electric power plants at the mines obtain coal at \$3 a ton or less.

Great economies have continually been effected in coal use. In 1900 it took an average of about seven pounds of coal to produce one kilowatt-hour of electricity. The corresponding figure in 1944 was 1.30

SENSATIONAL WAR BARGAINS in LENSES and PRISMS

NOW! MAKE YOUR OWN BINOCULARS!



FLASH! JUST RECEIVED!

We now have Metal Parts and Bodies for Navy's 7 x 50 Binocular Complete details sent with all orders for sets shown to the right or upon request.

Complete Sets of LENSES and PRISMS
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Here's an unusual opportunity to secure a fine set of Binoculars at a tremendous saving of money. Build them yourself with all of the very same optics contained in the Navy's 7 Power Glasses the Binoculars which received such wide acclaim during the war. Depending on your choice, you may buy a near perfect set of Lenses and Prisms for the Binocular construction job, or a set of seconds (exactly the same units, but Lenses are unmounted and have some imperfections). If, however, you wish to construct a Monocular ($\frac{1}{2}$ a Binocular) you may do so, choosing either near perfect components or seconds. The Monocular Sets comprise $\frac{1}{2}$ quantities of the same optics required for the Binocular. The full near perfect Binocular Set comprises the following—2 Cemented Achromatic Eye Piece Lenses, 175 mms diam., 2 Eye Field Lenses, 4 Porro Prisms, 2 Cemented Achromatic Objective Lenses, diam 52 mms. Complete assembly directions included, but no metal parts.

Stock #5102-S
Near Perfect Binocular Set \$25.00 Postpaid
Stock #5103-S
Near Perfect Monocular Set \$12.50 Postpaid
Stock #5105-S
Seconds for Binoculars \$11.00 Postpaid
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Seconds for Monocular \$ 5.50 Postpaid

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Set #1-S—"Our Advertising Special"—15 Lenses for \$1.60 Postpaid, plus 10-page idea booklet. For copying, ULTRA CLOSE-UP SHOTS, macrophotography, experimental optics, magnifying and for making a two power 1/16 Telephoto Lens, "Dummy Camera," Kodachrome viewer, DETACHABLE REFLEX VIEWFINDER for 35 mm cameras, stereoscopic viewer, ground glass and enlarging focusing aids, TELESCOPES, low Power Microscopes and for many other uses.

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Contains wide variety of projects and fully covers the fascinating uses of all Lenses in sets listed above. Only \$1.00 Postpaid.

35 MM KODACHROME PROJECTING LENS SET—Consists of Achromatic Lens for projecting, plus a Condensing Lens and piece of Heat Absorbing Glass with directions.

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SPECTROSCOPE SETS—These sets contain all Lenses and Prisms you need to make a Spectroscope plus FREE 15-page Instruction Booklet.

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ALL THE LENSES YOU NEED TO MAKE YOUR OWN TELESCOPE!

ALL ARE ACHROMATIC LENSES

GALILEAN TYPE—Simplest to make but has narrow field of view.

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REMARKABLE VALUE!

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PERFECT LENSES
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Complete System from Artillery Scope (5X) . . . 9 Lenses low reflection coated, absolutely Perfect. Diameters range from 1 1/3 inches to 2 1/5 inches. Used for making Telescopes and hundreds of other uses.

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Stock No.	Dia. in mms.	F.L. in mms.	Price
6158-S*	18	80	\$1.00
6159-S	22	51	1.25
6161-S	24	48	1.25
6162-S	25	122	1.25
6164-S*	26	104	.80
6165-S	27	185	1.00
6166-S	29	54	1.25
6168-S	29	76	1.25
6169-S	31	122	1.50
6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	63	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25

*ASTERISKED ITEMS are unmounted, but FREE cement and Directions included with unmounted sets. USES—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Macro-photography, Gadgets, Optical Instruments etc etc.

BIG DOUBLE CONVEX LENS—74 mm diam. 99 mm F.L. Weighs 9 oz. Made of borosilicate Crown Optical Glass. Used as spotlight Lens, Condensing Lens, etc.

Stock No 1048-S \$1.50 Postpaid

OPTICS FROM 4-POWER PANORAMIC TELESCOPE—Excellent condition. Consists of Objective Prism, Dove Prism, Achromatic Objective Lens, Amici Roof Prism, Eye Lens Set (. . . a \$60.00 value).

Stock No 5016-S \$6.00 Postpaid

RIGHT ANGLE PRISM—Flint Optical Glass size 41 mm by 91 mm by 64 mm. Use in front of camera Lens to take pictures to right or left while pointing camera straight ahead. Also used in front of camera Lens to reverse image in direct positive work. Two of these Prisms will make an erecting system for a Telescope.

Stock No 3076-S \$3.00 Postpaid

MAGNIFIER SET—5 magnifying Lenses—Powers from 1 to 10

Stock No. 1026-S \$2.00 Postpaid

PRISMS

Stock No.	Type	Base Width	Base Length	Price
3040-S	Right Angle	33 mms.	23 mms.	\$1.00
3045-S	Right Angle	70 mms.	168 mms.	4.00
3001-S	Lens Surface	20 mms.	14 mms.	2.00
3006-S	Porro-Abbe	9 mms.	9 mms.	.25
3009-S	Porro	52 mms.	25 mms.	1.00
3010-S	Porro	43 mms.	21 mms.	.50
3016-S	Pentagon	45 mms.	22 mms.	.75
3029-S	Dove	16 mms.	65 mms.	1.25
3036-S	80 Degree Roof	60 mms.	36 mms.	4.00
3049-S	Right Angle	69 mms.	167 mms.	10.00
3047-S	Right Angle	53 mms.	103 mms.	4.00
3038-S	Roof Prism	18 mms.	34 mms.	2.50

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TO KEEP POSTED on all our new Optical Items, send 10c and your name and address to get on our regular "Flash" mailing list.

SECONDS IN PLANO-CONVEX CONDENSING LENSES

Stock #1061-S—Diam 5 1/2" 51 F.L. 9" \$2.00 each Postpaid

Stock #1068-S—Diam 4-7/16" 6 1/2" 70c each Postpaid

We have a large supply of other seconds in Condensing Lenses for Spotlights and Enlargers—diam from 3 1/2" to 6 1/2"—priced very low. Write for list!

MICROSCOPE SETS

Consisting of two Achromatic Lenses and two Convex Eye Piece Lenses which you can use to make a 40 Power Pocket Microscope, or 140 Power Regular Size Microscope. These color corrected Lenses will give you excellent definition.

Stock No. 1052-S \$3.00 Postpaid

Consisting of Prism, Mirror and Condensing Lens. These used together with Stock No 1052-S will make magnification of 400 to 1000 Power according to screen distance.

Stock No 1038-S \$2.00 Postpaid

LENS CLEANING TISSUE—In spite of paper shortage, we offer an exceptional bargain in first quality Lens Cleaning Tissue. You get 3 to 4 times as much tissue as when you buy in the ordinary small booklets. One ream—480 sheets, size 7 3/4" x 10 3/4".

Stock No 704-S \$1.50 Postpaid

RAW OPTICAL GLASS

An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint glass (seconds) in varying stages of processing. Many prism blanks.

Stock No 703-S—8 lbs (min. wt.)—\$5.00 Postpaid

Stock No 702-S—1 1/2 lbs. \$1.00 Postpaid

MISCELLANEOUS ITEMS

Stock No	Item	Price
1031-S	6 Power Magnifier—Diam 29 mm Each	\$ 25
2043-S	Standard Crossline Reticle—Diam 29 mm Each	.50
1034-S	Burning Glass Lens Each	.25
2024-S	10 Pieces Circular A-1 Plate Glass (Diam 31 mm—for making Filter)	.25
523-S	Six Threaded Metal Reticle Cells	.25
624-S	Neutral Ray Filter, size 4 1/4" x 2 1/4"	.25
3022-S	Round Wedge, 65 mm Diam Each	5.00
3021-S	Amici Roof Prism (3rd grade) Each	.25
1030-S	2" Diam Reducing Lens, Each	.20
535-S	Small First Surface Mirror	.30¢ each
3003-S	Amici Roof Prism with Corrected Roof	\$2.50 each
633-S	Combination Polarizing and Infra-Red Filters, diam. 20 mm	50¢

(Minimum order on above \$1.00)

TANK PRISMS PLAIN OR SILVERED

90-45-45 deg 5 3/4" long, 2 1/4" wide, finely ground and polished. Perfect condition. Would normally retail from \$24 to \$30 each.

Stock #3004-S—Silvered Prism \$2.00 Postpaid

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Illustrated Book on Prisms included FREE

TANK PERISCOPE

Complete Set Mounted Components. Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Would normally retail at \$40 to \$50. Stock No. 700-S \$2.00. Complete Set Postpaid.

Order by Set or Stock No. — Satisfaction Guaranteed — Immediate Delivery

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pounds and efficient plants are able to produce a kilowatt-hour today with the consumption of only approximately three-fourths of a pound of coal.

All of this explains why James D. Francis, a Director of Bituminous Coal Institute and president of Island Creek and other coal companies, states that "in view of the excessive coal cost quoted in the atomic discussion, it would appear to me that it will not be three years or twenty-five years, but something like two or three generations before bituminous coal has anything to fear from atomic energy."

TRACTOR JACK

Combines Hydraulic Power and Ingenuity to Ease Job

VIRTUALLY able to lift a farm tractor "by its own bootstraps," a new hydraulic jack is now available that promises to ease materially the problems of changing tires and wheels. Consisting of a tubular framework which connects to the three-point hydraulically controlled linkage of the Ford-Ferguson tractor, it is claimed that the jack can be placed in operation in less than a minute.

When seen in position to lift, the device consists of two tubular arms sloping downward and forward with cradles at the top in which rests the tractor's rear axle. These act as pedestals, which are connected at their bottom with sleeves around an anchoring crossbar, which is the bottom of a four-sided tubular frame. This tubular frame extends beyond the rear of the axle and slants upward to connect with the two lower links of the three-link hitch on the rear of the tractor.

Hydraulic power, controlled from the driver's seat, is applied through the links to swing the frame, using the ground as a pivot, so that the

axle rides upward and forward and meshes into the cradles. It is possible to lift the tractor to any height up to four inches.

The manufacturer, the K-P Company, collaborated with Ferguson engineers in designing the jack.

REFLECTION CONTROL

Coatings Applied Easily to Glass and Other Materials

GLARELESS glass and transparent mirrors can now be produced as a result of new techniques for controlling light reflections developed originally to increase the efficiency of military optical instruments and radar equipment. The techniques control light reflected from large areas of glass, plastics, paper, oil paintings, and photographic prints without the use of acids or cumbersome equipment. In addition, it is said that the usefulness of reflection control is broadened by the new methods because previous anti-reflection techniques were generally limited to glass and were practical for small pieces only. An interesting feature of the reflection control techniques is their ability to increase reflections as well as to reduce them.

As explained by the developers, the American Optical Company, ordinary clear glass transmits about 92 percent of light, the remainder being lost through reflections. The 8 percent of reflectivity can be increased by the new technique to over 70 percent, and a piece of glass so treated resembles a mirror in that an observer can see his face reflected in it although the glass is transparent and can be seen through. Such a reflecting glass can also be made to acquire the characteristics of a filter, transmitting certain colors and reflecting others, a phenomenon that may be useful in taking color pictures. Other potential uses for



The disk of glass acts as a mirror, yet is transparent. The effect is obtained through the use of new glass coatings which can be applied to increase or decrease the amount of light reflected from the surface as desired.

this glass include windows that would reflect the sun's heat rays from air-conditioned houses and vehicles, and one-way glass doors or windows for refrigerators and ovens, the glass in this instance being opaque until an interior light is switched on, after which it becomes transparent. The glass can also be utilized for structural and decorative colored mirrors.

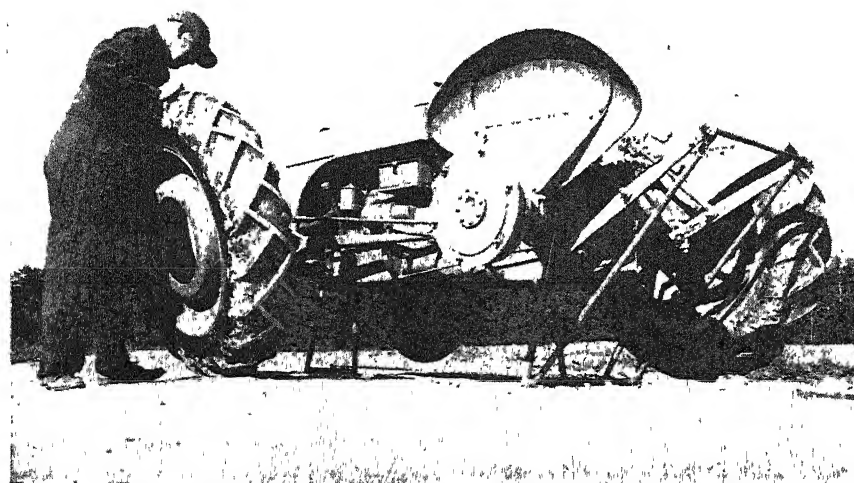
When applied to the reduction of reflections, as in binocular lenses and prisms, the light control techniques permit a gain of over 60 percent in light transmission, thus enabling observers to see distant objects better in dim light. Used in an optical instrument containing a series of seven lenses, a light loss of nearly 43 percent is reduced to 10 percent. With respect to camera lenses, the lens speed is increased and false images or "ghosts" are minimized.

Three general types of reflection-reduction coatings have been developed for different uses, ranging from highly efficient compositions of moderate durability to efficient coatings of great durability. Depending on the size and shape of the substance undergoing treatment, the chemicals which produce coatings can be applied by either of four relatively simple methods; dipping, spinning, spraying, or swabbing.

RUBBER IN PRINTING

Will Probably be Replaced By Non-Swelling Synthetic

BECAUSE of their ability to resist chemicals and oils in ink, certain synthetic rubbers are superior to natural rubber for inking rollers, printing plates, press blankets, and



Hydraulic system on tractor actuates new jack for changing tires

other rubber printing materials, according to United States Rubber Company. The principal difficulty with natural rubber is that it had a tendency to swell when exposed to ink, throwing the printing out of register and causing deterioration of the rubber. One of the outstanding virtues of buna N and Neoprene synthetic rubbers, according to the company, is that they resist this swelling.

It is probable that the printing industry will use rubber on a greatly increased scale in the post-war world. This expansion will extend mainly to inking rollers and printing plates, both molded and engraved. Rubber plates have been found far superior for printing on cellophane, wax paper, fine stationery paper, box board, bags, and other materials possessing a delicate surface easily cut or broken by metal plates.

FRESH CREAM

*Processed To Keep Sweet
and Tasty For Year or More*

SO-CALLED "flash sterilization," followed by bottling and hermetically sealing, will soon enable consumers to keep fresh cream for over a year at normal room temperatures. The cream is not pasteurized, but is sterilized, and processing requires only four minutes. Scientifically conditioned air in the bottling and capping room is assured by use of the Precipitron, which electrically cleans the air of dust particles, and of Sterilamps, which will kill germs by ultra-violet rays. Both devices were perfected by the Westinghouse Electric Corporation. The California Milk Products Company are the originators of the new process.

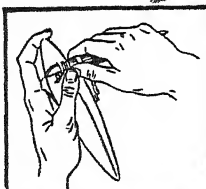
HEAVY-DUTY MOTORS

*May Combine Diesel Engine,
Supercharger, and Turbine*

POWERPLANTS of future heavy-duty motor vehicles may consist of a combination of Diesel engine, supercharger, and turbine, according to R. W. McLaughlin and C. F. Harms, of Elliott Company. As an effective method of putting exhaust gas to work, they explained, the application of the supercharger would increase the engine's power output approximately by 50 percent, and the turbine would perform useful work in driving the supercharger. They added that future possibilities include utilization of the Diesel engine merely to function as combustion chamber for the turbine and to drive the supercharger, with the turbine itself becoming the source of power.

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like the "1001" Re-Blade Knife*
with interchangeable surgical steel blades

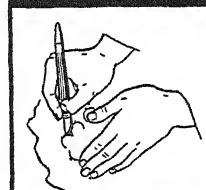
KEEN!
EVER
SHARP!
EVER
READY!



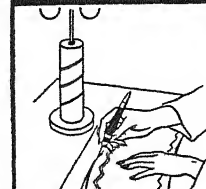
For Hobbyists



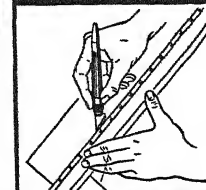
For Photographers



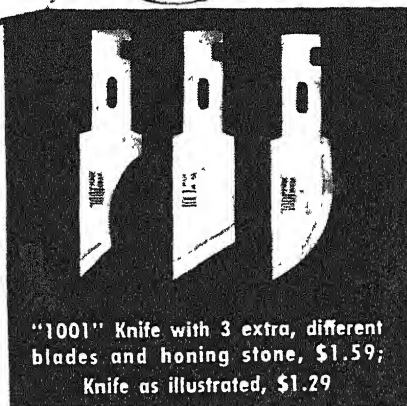
For Craftsmen



For Home Makers



For Artists



"1001" Knife with 3 extra, different blades and honing stone, \$1.59;
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"1001" Knife
Blades Are
Made of Finest
Surgical Steel

Different blades for different purposes—of finest surgical steel, carefully tempered, precision ground. Designed to serve even the most painstaking craftsman.

Now — the first really "balanced" craft knife you've been waiting for!

Whether you're an expert craftsman or just a passably fair workman or hobbyist, you'll do better work faster and easier with "1001"—the re-blade knife of 1001 uses! For "1001", thanks to its light, perfectly balanced, colorful plastic handle, is second to none for easy and exact whittling, chiseling, modeling and cutting of all sorts. Its patented, scientifically designed chromium finish blade holder simplifies the insertion and removal of "1001's" all-purpose blades, and keeps them firmly locked in place. Which explains in large part why so many thousands of hobbyists, craftsmen, photographers, artists, home makers, etc., are singing "1001's" praises! Yourself—get a "1001"—feel the difference, see the difference in your work. It's as easy to handle as a pen or pencil.

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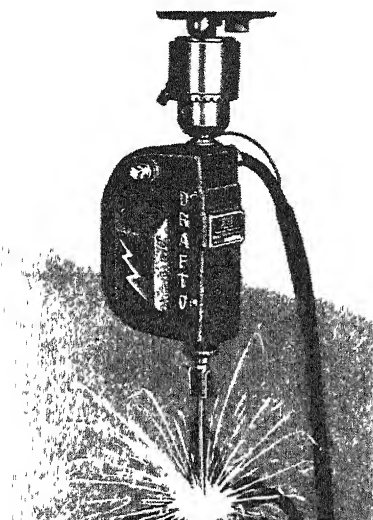
*PAT. PENDING

New Products and Processes

BROKEN DRILLS AND TAPS

*Removed Without Damage by
Electrical "Sputterer"*

A METAL disintegrator which rapidly and safely removes broken taps and drills from work in progress, thus saving the piece, was recently an-



Cuts hard materials; useful as a drill

nounced by the Drafto Corporation. Based on the electrical "sputtering" principle, the new Disintegrator, it is claimed, will remove broken drills or taps from work without injuring the metal of the workpiece, and regardless of the hardness of the metal, or will bore through hardened high-speed steel at the rate of about 1/16 inch per minute.

When used as a drill, the device will drill holes of practically any shape through tungsten carbide and Stellite, and will cut virtually all hard metallic materials.

Electrodes range in sizes from .065 to .310 inch in diameter, and square electrodes up to 1/2 inch. Two portable models and a table model are available.

SEALING MACHINE

*Applies Tape to Container
Lids Automatically*

A TAPE-SEALING machine, for applying air-tight, moisture-proof tape to containers of coffee, baking powder, tobacco, and so on, is reported to increase the sealing rate to 25 containers per minute as compared to the former rate of six per minute for manual application. At the same time, the machine incorporates an easy-opening paper tab in the sealed tape.

The sticky tape, difficult to handle as it passes through the machine, is controlled by holding it against a guide bar by negative air pressure.

According to the manufacturer, the Package Machinery Company, the machine will accommodate round or square tin, glass, or other type containers ranging in diameter from two to four inches and in height from one half to six inches.

The cans or containers are fed into the machine on a conveyor belt. Each in turn is picked up by lugs and fed onto a turn-table device. This places the container in juxtaposition to the tape. The container then makes one complete revolution, pulling the tape from the spool. At the end of the revolution an automatic knife cuts off the tape, and the next container bumps the taped can onto a discharge belt.

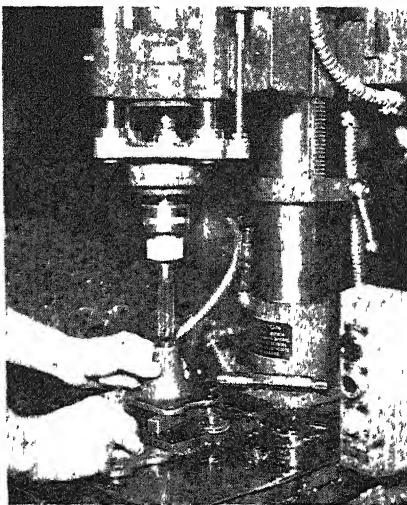
HIGH-SPEED TAP

*Cuts Precision Threads
in Eight Seconds*

AUTOMOTIVE spring hangers of a new type, having thread designs which provide greater area to resist radial and thrust loads and should therefore result in decreased wear, are now being threaded in only eight seconds per hanger, floor to floor time.

The thread design, which is an 893 inch-11, straight side obtuse form with a 149 degree 43 foot included angle, is said to eliminate the necessity of a locking device, permit axial adjustment for alignment, provide full-length paths for the lubricant, allow limited oscillatory movement, and make possible the engagement of new contact surfaces to compensate for wear.

To thread the hangers, a Detroit Tap and Tool Company light-duty tapping



Lead-screw machine eliminates clamps

machine is used for precision tapping to a depth of 1-45/64 inch with a standard six-flute tap ground with a four-thread chamfer. The tap is mounted in a floating tap-holder and the work is placed on a simple two-pin locating fixture without clamping. It is claimed that clamping is made unnecessary by use of the lead-screw type machine, which eliminates any tendency for the tap to bind on the return stroke. Tapping cycle is semi-automatic—tap, return, stop—to assure positive feeding at the high spindle speed of 400 revolutions per minute.

TINY PARTS WELDED

*While Gripped in
Tweezer-Type Electrodes*

TWEEZER spot welding, with a portable unit weighing approximately 25 pounds, is now available for many metal fabricating uses. The welder uses 115 volt, 60 cycle power and may be used on metal parts measuring .0005 to 1/8-inch round or thick. To weld parts from .015- through 1/8-inch round, the ma-



Welding current flows 1/1000 second

chine is used with an auxiliary booster unit.

Heretofore, the welding of tiny parts has been limited because of the inherent difficulty in holding them in order to effect the weld. With the use of the tweezers, the electrodes may be applied directly to the elements to be joined. The tweezers probe for the parts, hold and bend them, and weld.

Because the voltage used is low, and the current flows through the welding tweezers for only about 1/1000 of a second, the tweezers may be held safely in the hands. A foot switch controls the welding current.

For heavy gage metal where more pressure is required, the tweezers may be removed and the welding machine connected to a drill press or hand arbor. With this method, as explained by the Tweezer-Weld Corporation, copper or copper-alloy rods may be inserted as electrodes with only the bottom electrode insulated.

PAPER WET STRENGTH

*Increased by Resin
Without Special Handling*

WET-STRENGTH improvement of paper is reported to be obtained with a resin named Uformite 470, that represents

a new type of urea-formaldehyde resin modification, and requires no special handling, aging, or pre-treatment before use. After dilution with water, the resin is ready for immediate addition to the paper stock prior to sheet formation. According to its makers, The Resinous Products and Chemical Company, the resin represents an advance over previous types in that it offers superior retention and wet-strength development on sulfite, rag, and groundwood stocks; high wet strength with all stocks at low acidity; effectiveness with minimum alum or acid alone as catalyst, and excellent durability of wet and dry strength.

Development work to date with this resin has indicated particular effectiveness in producing high wet-strength glassine, towelling, light-weight absorbent tissues, sulfite wrapping papers, and blue-print, map, chart, and ledger papers.

LIGHTEST SOLID

Lithium Metal, Now Ready for Wider Industrial Use

NEW USES for compounds of lithium, lightest of all solid elements, were reported as available for industry, at a recent meeting of the American Society of Mechanical Engineers.

Although lithium is at one end of the periodic table of elements and uranium at the other, it was indicated that lithium may play a prominent part in nuclear physics investigations in the near future. Three lithium products new to industry, as described by Dr. Hans Osborg of the Luthalloys Corporation, included: lithium peroxide, a solid possessing high stability and providing approximately 35 percent free oxygen by weight; lithium borohydride, a solid stable in dry air, which generates 66 cubic feet of hydrogen per pound, in contact with water; and diborane, a gas at room temperature which liberates 78 cubic feet of hydrogen per pound when in contact with water.

The advances made in lithium technology have led to applications in the aircraft, chemical, electrical, air-conditioning, glass, ceramics, optical, and metallurgical industries. Lithium is used as a super-refining agent in metallurgy and as an alloying constituent in low-melting alloys. Lithium compounds are also used in aluminum welding, making of magnesium castings in the aircraft industry, air purification, and in air-sea rescue work.

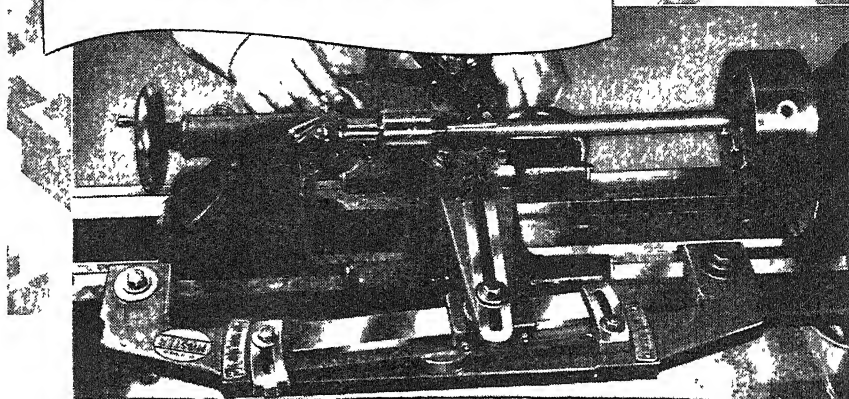
ELECTRONIC BALANCER

Detects Amount and Location of Unbalance

A NEW electronic tool, so sensitive that it will detect the unbalance caused in a rotating body by the presence of a single wisp of lint, now is being made available to industry. Known as the Microbalancer and equally effective in balancing large or small rotors, the device is said to eliminate expensive imperfections in balance from rotating equipment.

Ingenious New Technical Methods

To Help You with Your Reconversion Problems



Simplified Master Taper Attachment Fits All Types of Lathes Instantly!

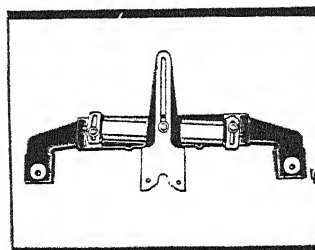
Now! A "universal" taper attachment that fits all lathes, old or new, big or small—that can be attached or removed in *minutes!* This taper attachment is not bulky or cumbersome. It bolts easily to the bed, in the back of any lathe.

The Master performs accurate taper turning, boring and threading with the ease of any straight line tool operation. It precisely duplicates any tapered part. It is usable in any position. Does not interfere with straight turning. The bar is precisely machined and fitted. There is no vibration. Taper graduations are in inches at one end; degrees at the other. The Master is available now, in two sizes; two feet and four feet in length.

Available today also, is delicious Wrigley's Spearmint Gum. This is one treat you can enjoy even when your hands are busy. And the pleasant chewing helps to keep you alert and wide-awake, even through a monotonous job.

Chewing Wrigley's Spearmint satisfies a fellow. In addition, it helps keep your mouth moist and fresh—so you feel better. And feeling better, you naturally work better. By making gum available to all, scores of plants and factories report increased morale and efficiency that really pays off.

You can get complete information from the Keene Electrical Machinery Co., 549 W. Washington Blvd., Chicago 6, Ill.



Model 710 Master Taper Attachment



AA-63

A survey of the equipment benefiting from such delicate balancing operations on rotating parts includes: superchargers for the internal combustion engines, gas-turbines, and gyroscopic units for robot airplane pilots.

In operation, the microbalancer ferrets out the exact location of unbalance, measures its weight, and indicates the amount of correction to be applied. It can detect unbalance caused by a weight of one-millionth of a pound on a small area of a ten-pound rotor; or it can in effect determine vibration amplitudes as small as a quarter of a millionth of an inch—about the wavelength of X-rays.

Work to be balanced is suspended in a horizontal position between two floating bearings and rotated by an electric motor drive. Analysis is made

in two separate but simultaneous and complementary operations. One determines the amount of any unbalance; the other locates the exact position on the circumference of the work at which weight must be added or removed to correct this condition. To aid the latter operation, identifying numbers are located around the circumference of the work. Vibrations caused by any unbalance are picked up mechanically from each bearing support and converted into electrical energy. These fluctuating voltages—read on a simple meter—indicate the amount of vibration or unbalance.

Position of any unbalance is determined by using a photo-electric cell and a stroboscope. Special electrical circuits cause this light to illuminate the work which appears to stand still

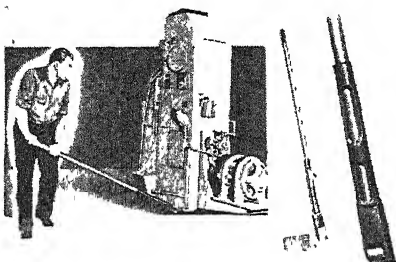
with the exact point of unbalance—readily identified by its number—holding steady under a pointer.

Addition or removal of the indicated weight at this point brings the work into perfect balance. Developed by Westinghouse Electric Corporation, the balancer will be incorporated in production machines by the Gisholt Machine Company.

LIFTING BAR

*Has Roller Fulcrum,
Changeable Toe Plates*

A new lifting bar with which one man can easily lift as much as a five-ton load, is described as having a hardened steel roller for extra leverage, and ledges for safe gripping. Its manufacturer, the Arnolt Motor Company, offers the bar with three styles of interchangeable toe plates: notched for prying up spikes and lag bolts and



Straight, notched, and rubber-coated ends adapt prying edge to job needs

getting under heads and corners; straight-edged for general lifting and moving; and straight-edged with rubber-coating to prevent scratching enameled or finished surfaces. Both one-ton and five-ton sizes are available.

RECORDER TUBE

*Gives Accurately Modulated
Point-Of-Light Source*

A MODULATOR glow tube of the crater type for facsimile and sound-on-film recording, oscillograph timing markers, stroboscopic devices, seismic recorders, and photo-electric counters, recently developed, is reported to be unusually rugged and dependable.

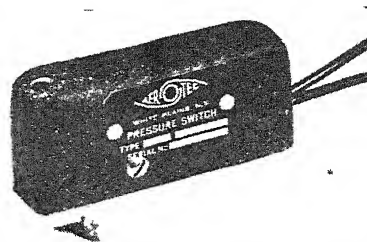
Usually operated by the single-ended output stage of a push-pull amplifier, the tube provides a modulated, high intensity point-of-light source by means of a hollow cathode producing high ionization density.

Current through the tube varies linearly with the signal voltage regardless of changes in tube impedance while light output-current characteristics produce good average light response and mica baffles reduce bulb blackening, according to the manufacturers, Sylvania Electric Products, Inc.

PRESSURE SWITCHES

*Have Varied Adjustment
and Re-set Features*

DEVELOPMENT of three new eight-ounce switches, operable on either pressure or vacuum up to 200 pounds, for con-



Liquid or gas-actuated over 200-pound range, switches have 10 ampere rating

trolling liquids or gases that will not corrode brass, was recently announced by the Aerotec Company.

Typical applications are to compressors, pumps, and carbonated-beverage equipment, and the switches are rated at 10 amperes on 110-volt AC. One switch has an externally adjustable range with a fixed differential; the second can be reset manually from the outside; and the third type has an adjustable differential. Contact arrangement in the first two can be specified as normally-closed, normally-open, or double throw. The third design is available only with normally-open contacts. Pressure connection is by means of a 1/8-inch pipe nipple.

AIR HOIST

*Weights 30 Pounds;
Lifts 1000 Pounds*

FILLING an industrial-plant need for portable 1/4- and 1/2-ton hoists is a recently developed unit that, under accelerated break-down tests, has shown the capability of attaining the rated capacity of 17 feet per minute with a full load of 1000 pounds. Lesser loads were lifted at proportionately greater speeds. According to the makers, the Keller Tool Company, one man can carry the hoist comfortably and without fatigue; it weighs only 30 pounds.

The hoist housing, a one-piece alloy casting of high tensile strength, maintains all parts in alignment and also supports the air motor which is of



Lightened by aluminum housing design, portable half-ton hoist is easily carried or installed by one person

vertical piston design. The motor is said to start and stop instantly.

Variable speeds, from a "creep" needed to place a load carefully into position to a maximum speed of 17 feet per minute, are obtained by a control bar that opens a poppet-type throttle valve, slides a reversing valve

into the desired position, releases the brake, and raises or lowers the load. The enclosed, centrifugally-governed brake is fully mechanical.

To prevent the hoist from operating beyond a safe working position, safety limit stops are provided at both ends of the lifting chain which is tested to carry over six times the maximum-rated load. A hardened-steel chain stripper prevents the chain from tangling.

The hoist is driven by planetary-type gears supported on ball bearings, as is the load shaft and other rotating parts. Dimensions of the hoist are: 13 1/4 inches hook-to-hook; 5 inches wall clearance; 14 1/2 inches overall length.

Five hundred-pound and 1000-pound capacities are available.

THERMOPLASTICS AND CERAMIC

*Joined to Make Re-Meltable
Multi-Purpose Material*

FINISHED castings in only five minutes, which can be reclaimed like metals by melting, are possible with a combined ceramic and thermoplastic called "Plastiform," developed by Duorite Plastic Industries. Used in making tools for aircraft work, art objects, protective coverings, insulators, scenic casts for stage and motion picture sets, toys, and office equipment, Plastiform is prepared for casting by melting in a double boiler. It can be melted or remelted innumerable times without additives. Above 240 degrees, Fahrenheit, the material becomes a fluid which can be poured, brushed, sprayed, dipped, or molded into almost any form. The fluid solidifies into a finished casting in five minutes or less. Plastiform dies for stretching metal parts are said to have withstood loads of as much as 1,250,000 pounds. Broken castings can be patched with an ordinary soldering iron.

MERCURY ARC LAMP

*Equals 125 40-Watt Bulbs;
Is Air-Cooled*

A 1000-WATT tubular bulb, said to be the most brilliant lamp ever developed for general commercial use, was announced recently by the Westinghouse Lamp Division. The air-cooled lamp produces 60 lumens for each watt of electricity consumed, and the total light output of 60,000 lumens is equivalent to the light cast by a canopy of 125 incandescent bulbs of



40-watt size. Over-all, the lamp measures 14 inches long and is less than four inches in diameter.

Designed primarily for lighting high-ceiling factories, baseball diamonds, indoor sports arenas, and other expansive areas where a high level of lighting with a minimum of reflectors is desirable, the lamp is also well adapted



Inner quartz tube houses arc stream at four times previous vapor pressure. Lamp will burn in any position

for unusual applications such as the lighting of arc-welding booths

The unusual light intensity was made possible by boosting the mercury vapor pressure inside the tube four times beyond pressure levels used previously. When electricity passes into the lamp, the mercury vaporizes and a flaming arc forms between the two electrodes, located on each end of the tube. The entire light source is the arc itself.

Equipped with a mogul-screw base—the same type as in high-wattage incandescent lamps—the new bulb can be burned in any position. A voltage step-up transformer and a simple current limiting device called a reactor, are used to supply current for the arc. Because the new bulb, operating at 1100 to 1300 degrees, Fahrenheit, generates much less heat than previous water-cooled lamps, it requires only a normal amount of natural surrounding air as a cooling medium

FINER DDT POWDER

*Permits Accurate Mixing,
Dusts More Evenly*

MADE-TO-ORDER solutions of DDT, designed to meet specific garden and household needs, are now being made available with the aid of new "micro-nized" grinding techniques. Developed by National Magnesium Corporation in the course of war-time experiments on magnesium powder, the grinding methods produce an extremely fine powder and are said to eliminate jamming, filling, and coarse agglomerates which previously made dusting and spraying with DDT difficult.

"Prescription method" mixing is aimed at stepping-up the insecticidal efficiency of DDT while materially

diminishing the DDT content of the solutions. By using the proper solution, the toxic potentiality of the insecticide to animals, humans, and birds can be minimized while the usefulness of DDT against insect pests is increased. Also, the uniformly fine powder promises to improve airplane dusting, heretofore handicapped by variations in grain size, which caused dusting devices to clog or distribute the powder unevenly

SCRAP RUBBER SORTING

*Speeded by Color-Changing
Sensitized Paper*

BEFORE the advent of synthetic rubber, reclaiming plants had no difficulty

in separating different types of basic natural rubbers; now the use of increasing quantities of GR-S and other synthetics, which must be reclaimed by varying methods, has created a sorting problem.

A test developed by Mr. Harry P. Burchfield of United States Rubber Company has the advantage of being simple and reliable. It is based on the discovery that paper, impregnated with special chemicals, will develop characteristic colors when exposed to smoke from different types of rubber branded with a hot iron. For example, the smoke from a synthetic GR-S tire will turn the paper green, but smoke from natural rubber will turn it blue. Similarly, oil-resisting synthetic GR-M or Neoprene will produce a character-



A well designed and efficient production line with high speed end-tower EXACT WEIGHT Scales. California Consumer Corp. plant, Pasadena, Calif.

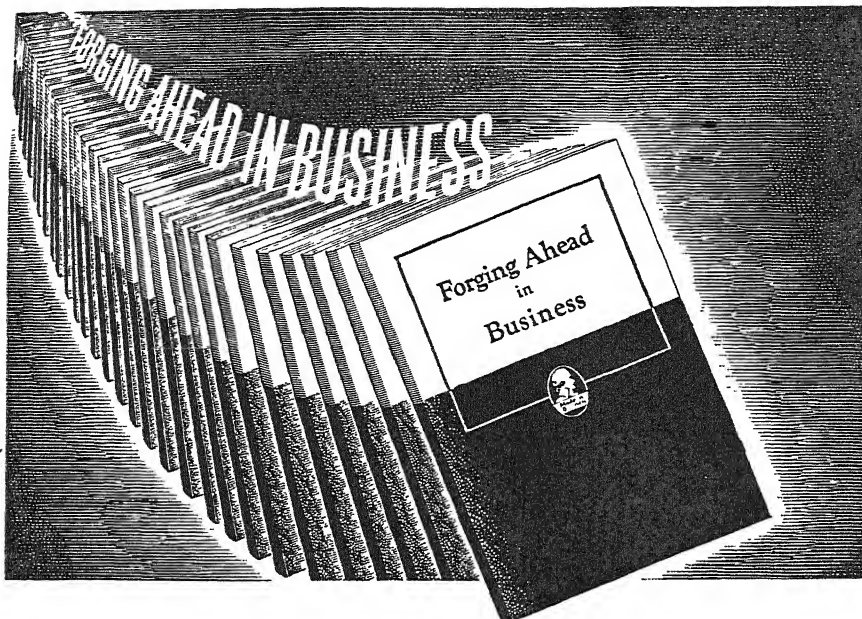
The Frozen Food Industry . . .

The frozen food industry is big business now, but it is only beginning. This giant young industry is demanding and buying much equipment. One of the main equipment requirements in volume frozen food production is checkweighing scales for uniform containers and profitable operation. Such equipment should fit this particular business . . . deliver absolute accuracy . . . be rugged . . . be easy to operate . . . be of the right capacity to handle the individual packages. These are the exacting specifications of EXACT WEIGHT Scales. You will find these precision scales in all leading food packaging operations nationally. This is but another of the more than fifty major industries served by these famous scales. Write for details for your business

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FORGING AHEAD IN BUSINESS contains a message of particular importance to production men. This is your opportunity to obtain a copy of this famous book, which has been described as a "turning point in the lives of literally thousands of men!"

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It demonstrates the method which the Alexander Hamilton Institute uses to give you immediate help in your present position, while preparing you for post-war opportunities. Subjects directly related to the work you are doing now, PLUS other subjects of fundamental value to the business executive, are discussed in the book and placed in significant relation to one another. Thus, a helpful, over-all picture is provided.

Said one man who had sent for "Forging Ahead in Business":

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... and that represents the opinion of

the Institute's 400,000 subscribers, including 134,000 production men!

The booklet further explains how it is possible to offer this essential training in a minimum of time, how the Institute program fits in with the most crowded of post-war schedules.

Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp., and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

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Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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The procedure is sufficiently rapid to be practical in the testing of representative samples from car-load shipments, or for establishing the identity of materials on which indecisive results are obtained by less specific methods.

MICROSCOPE MICROMETER

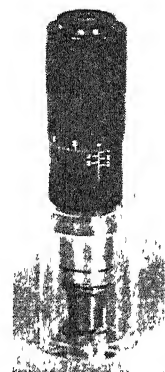
Measures Thickness of
Transparent Materials

CENTRAL portions of large sheets of glass or plastics are inaccessible to the ordinary micrometer. Also, the measurement of even small curved plastics sheet is exceedingly difficult by ordinary means, since the ball head of the mechanical micrometer tends to sink into the plastics. Similarly, optical surfaces may be damaged.

For these and similar cases, a new optical micrometer has been worked out on the principle of apparent depth.

Essentially, this instrument consists of a microscope, which is movable for focusing, and an outer tube with a

Crayon mark on
back of material is
brought into
sharp focus by means
of adjustable
barrel and
thimble marked like
standard type
micrometer

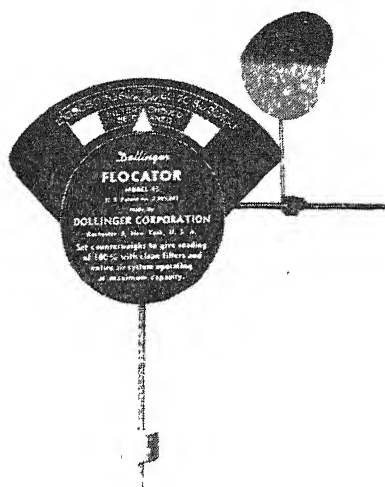


plastics nose-piece that is held against the sheet to be measured. In use, the transparent sheet is marked with a crayon on the side away from the instrument and the measurement is taken by sharply focusing the mark in the microscope. Readings on the barrel and thimble, similar to those on an ordinary micrometer, give directly the thickness of the sheet. The time involved is about the same as with the purely mechanical instrument. The optical micrometer is made by the Aireon Manufacturing Corporation.

AIR FLOW

In Heating Systems is
Indicated by Simple Unit

INDICATING the percentage of maximum air flow, a recently marketed low-cost device named Flocator mounts in the air duct of domestic forced-warm-air heating systems. Its most important function is to show when air filters need replacement or cleaning. Also, the indicator, made by the Dollinger Corporation, will warn against dry or damaged fan bearings, fan-belt slippage, dirt-coated fan blades, and constricted or damaged ducts or improperly adjusted dampers. An easily-read dial shows proper rate of air flow as well as percentage of re-



Shows when air filters need replacing

strictions as filters become increasingly loaded with dust. A sudden change in air flow indicates more serious trouble.

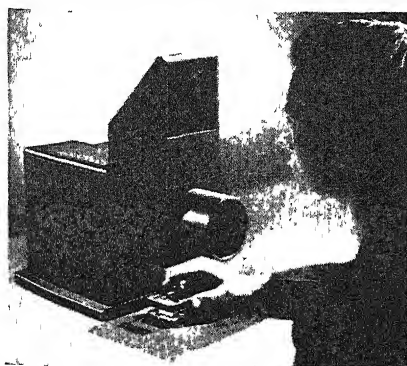
Installation in either vertical or horizontal ducts involves simply cutting a hole in the main duct approximately $2\frac{1}{2}$ by $\frac{1}{2}$ inch, mounting with self-tapping sheet metal screws, and adjusting the indicator to read 100 percent with clean air filters and with the system functioning properly.

INTERFERENCE VIEWER

Plus Rectangular Optical Flats
Add Uniformity to Light-Wave Tests

ACCURATE measurements of gage blocks, anvils, sealing surfaces, and other precision articles are reported to be obtainable with a newly designed interference viewer in which the interference patterns are both illuminated and viewed on a line perpendicular to the plane of the pattern. Distortion of the pattern is said to be eliminated and each pattern appears the same to different observers. This latter feature allows the inspection of one pattern by several observers, thus making instruction easier.

The monochromatic light source in the Optron Viewer is completely concealed, and the light wavelength—20.8 millionths of an inch—was selected to give interference patterns of maximum brightness and sharpness. To permit convenient comparisons of straightness or direct measurements between in-



Measurement scale may be superimposed on interference image pattern

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"A SIX ROOM HOUSE, \$2800.00 Complete Ready for You to Move In"

by George W Pearce

The author, a mechanical engineer, reviews the history of housing and shows how building costs have risen in the last 150 years until few families can buy a house adequate for their needs.

He then describes how, by the use of various money-saving building methods, a large, modern, 6-room, thoroughly insulated, fire resistant, 2-bath bungalow with garage can be had most anywhere in the United States for \$2800.00.

Included with the book are 10 folded drawings 12" wide x 18" long. These drawings by Mr. Pearce show all the details of construction for this house — the wiring, the plumbing, the automatic oil heating system and the fluorescent lighting. The book is devoted to showing how similar savings can be made on any house of any style, size or floor plan.

A very readable and interesting book. Every prospective home owner should have a copy 138 6" x 9" pages, 26 illustrations, leatherette bound, 10 large drawings.

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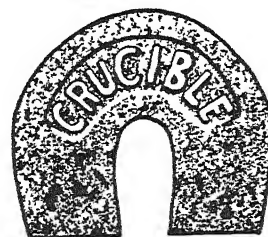
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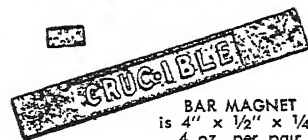
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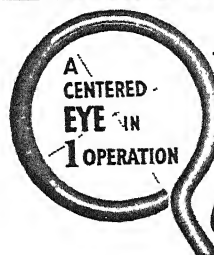
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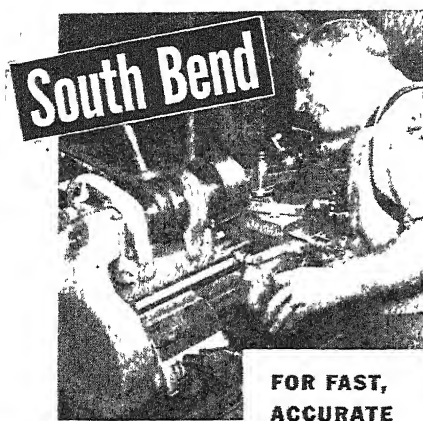
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terference bands, without using a ruler or straightedge, the user may superimpose the image of any convenient scale on the interference pattern itself. It is also claimed that the viewer permits the use of Haidinger bands in tests for parallelism, without accessories of any kind. Deviation in parallelism from ½ to 15 seconds may be detected with this system.

For use with the viewer, square and rectangular Opton flats are available and are claimed to be more economical and easier to handle than those of the conventional round shape. For example, a 10 by 2¾-inch flat can be used in place of a round flat 10 inch in diameter, but weighs only one fourth as much according to the makers, Opton Laboratory.

The straight edges of the flats provide reference lines for comparison of straightness of interference bands, and are said to reduce the need for rules or straightedges.

DIE-CASTING MACHINE

Can be Controlled
Automatically or Manually

E L I M I N A T I O N of cold metal from the shot furnace, improved hydraulic performance, automatic timing, and adjustable bearings for the movable platen are features of a new die-casting machine announced by The Cleveland Automatic Machine Company.

A double-compartment furnace, with separate automatic burners for each compartment, is said to eliminate the presence of cold metal in the shot compartment. New metal is placed in the second compartment, automatically causing the overflow of readied molten metal into the shot section. Even temperature and uniform condition of the shot metal are maintained by this method.

Uniformity in hydraulic performance is achieved by addition of a new heat-exchanger oil cooler. The water-flow heat absorption is augmented by fin construction of the outer shell which affords a high rate of heat radiation, and provides a combination of air and water cooling.

Automatic timing is combined with manual controls so that method of operation may be selected in accordance with the type of production involved. All controls are centered on a single panel close to the operating station. Bronze adjustable wedge-type slide

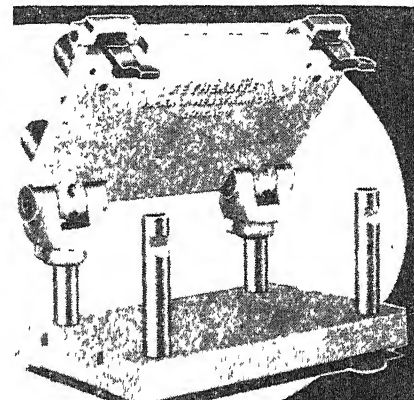
bearings, under the movable platen carry the full weight of the platen. This construction is described as strengthening the platen assembly and helping to maintain accurate alignment

LIGHT JIGS

Feature Instant
Opening and Closing

I F THE WEIGHT of jigs is reduced, jig operations can be speeded up, since weight is a primary factor in operator fatigue.

This is the basis on which "Fether-lite" Snap-Lock jigs were designed. Construction is of an aluminum alloy that is tough, durable, and easy to bore



Aluminum jig bores easily for bushings

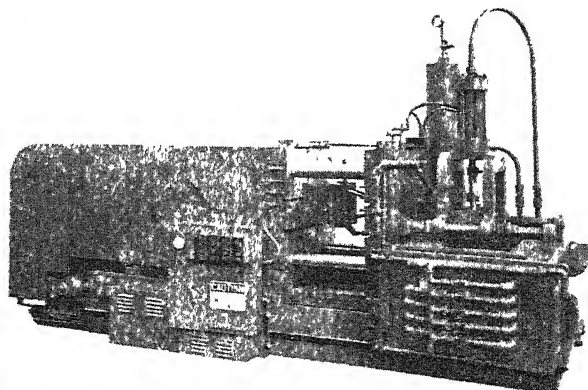
for bushings and pins. Its lightness—1/3 the weight of steel—makes possible easy shifting of the jigs to any position.

Lock construction permits instant opening and closing, so that loading and accurate placement of the work piece are speeded up. The unit is easily assembled into 1, 2, 3, or 4-way jig. Interchangeable posts accommodate work of practically any height. The new unit, made by Hedstrom Industries, Inc., is offered in many standard sizes.

HYDRAULIC PUMP

Delivers Large or Small
Volumes at High Pressures

P R O V I D I N G continuous-duty development of 5000 pounds per square inch at 40 horsepower, and delivering up to 17 gallons per minute at 1200 revolutions per minute, a new hydraulic pump is said to broaden substantially the po-



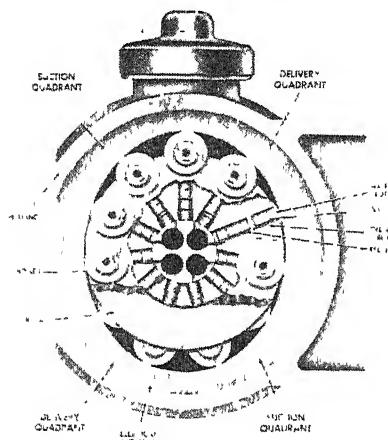
Double compartment furnace keeps hot and cold metal separated; shot metal maintains even temperature

tentialities of hydraulic design. The pump is light enough to be carried by one man.

Applications, in addition to the hydraulic-press and cylinder-actuated-machinery field, are expected to be found in test equipment; automotive, marine, and railroad hydraulic drives; and in the petroleum, Diesel, and plastics industries. Two models, either constant or variable delivery, are available.

Known as the Superdraulic Pump, and manufactured by Hydraulic Machinery, Inc. and Superdraulic Corporation, the pump operates on the radial-plunger principle. Centrifugal force maintains the plunger rollers in contact with an elliptical reaction ring which actuates the plungers to provide the desired pumping action.

Each plunger makes two inlet and two delivery strokes per revolution. Volume control is achieved by means of gears which turn the elliptical reaction rings—one ring for each bank of plungers—in opposite directions to vary the angular relationship of the major axes of the ellipses. At full



Section of new hydraulic pump showing shape of elliptical reaction ring

delivery, the major axis of these reaction rings are parallel, and at zero delivery the major axes are 90 degrees apart. Intermediate angles vary the pump delivery proportionately.

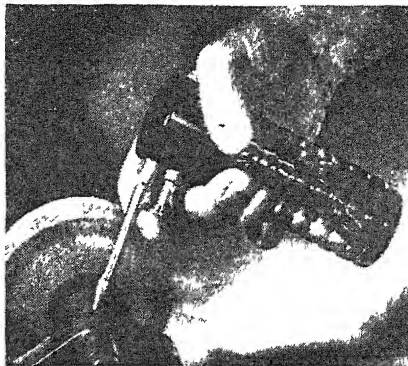
A small circulating pump provides circulating oil direct from the oil tank at near-zero pressure. This oil cools the pump housing under conditions of extreme pressure operation at zero or near-zero delivery.

OILER-SPRAYER

*Has Visible Supply;
Interchangeable Jets*

TRANSSPARENT Tenite plastics forms the half-pint barrel of a new oiler-and-sprayer. It can be used as an oiler for many garage, machine-shop, and household oiling jobs or as a sprayer for gardening, animal care, laundry, and general cleaning. The can is converted from oiler to sprayer, or vice versa, simply by changing nozzles and liquids.

Tenite provides not only visibility of the liquid level within the can, made by Midwest Production Machine Company, but also toughness and impact strength. The can may be dropped or



Plastics barrel is strong, transparent

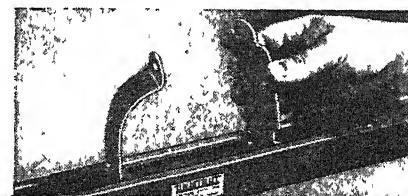
submitted to hard blows without shattering the tough material. A segmented design provides a good grip.

The plastics barrel screws onto a metal top, to which is attached a plunger-type mechanism. Properly primed, the pumping device delivers a charge of oil from one to one and one quarter cubic centimeters per stroke to a distance of not less than 48 inches. For priming, the handle requires not more than six full strokes

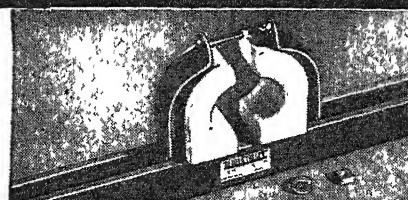
SIMPLE CLAMP

*For Use With Slotted
Structural Members*

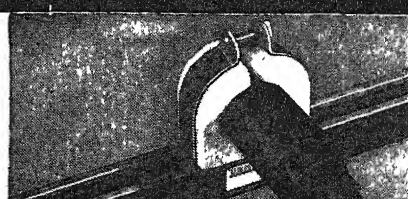
FOR USE on Unistrut hollow-square support members, a new clamp for cables, conduit, pipe, or wires, is installed by tightening a single bolt. There are no holes to locate or drill, the slot in the Unistrut member being the equivalent of a series of holes throughout its entire length. The pipe-strap clamps are hooked into the member as



1 How cable clamp straps are inserted.



2 Insulators in position.



3 One bolt tightens clamp, locks it to support.

Three steps in clamping insulator to slotted hollow-square support members

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illustrated, the insulating clamps are placed against the cable (the porcelain insulator is omitted for conduit or pipe), the bolt inserted, and the nut turned up tight. This closes the insulators firmly around the conductor and also causes the pipe-clamp straps to lock tightly.

SPATS AND LEGGINGS

Protect Legs and Ankles of Foundry Workers

SPECIFICALLY designed spats and leggings to afford complete leg protection for foundry and other industrial workers, with plus features of easy adjustment and quick release, were recently announced by American Optical Company.

The new leggings protect front, back, and sides of leg, from instep to knee. Available in chrome leather, specially



Industrial workers and others who need protection for legs and ankles can use these chrome-leather leggings. They are also made in asbestos and canvas. For instep and ankle protection, spats are available.

tanned to resist heat and hot metal splashes, they may also be obtained in asbestos or fire-resisting duck. All leggings have a chrome leather flare over the instep.

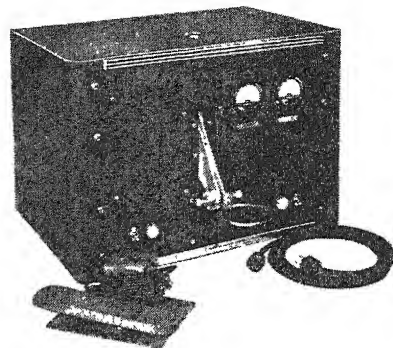
The spats are identical in construction with the legging, except for shorter length. Their design provides full protection for the instep and ankle of foundry and other workers.

INDUCTION-HEATER SOLDERING

Gives Clean Job at Lowered Cost

TO MEET the need for clean soldering of small parts, and for soldering of metal to metallized glass and ceramics, a new portable, bench-type induction heater is offered that is described as capable of materially reducing unit costs for soldering operations.

Made by the Marion Electrical Instrument Company, the low-powered induction heater was originally used by this firm for producing sealed instruments. Other uses included terminal assembly, magnet assembly, and bearing assembly, all of which are said to have been improved in quality and lowered in cost by the application of this unit. Advantages of induction-heat soldering are restriction of solder to the work area and the elimination of cleaning operations. Another advantage is that it is possible to jig-locate parts of the assembly accurately and avoid subsequent machine opera-



For soldering by induction

tions. Working efficiency of the induction heater is greatest when the work to be heated has a high resistivity, as in the case of ferro-magnetic materials, and somewhat less with low resistivity materials, such as copper and silver, because with these materials a smaller percentage of total power is converted to useful heat.

Applications seem indicated in the electronic industry, as well as in the production of jewelry, watches, toys, instruments, automobile parts, electrical-fixture components, household fixtures, and similar items involving small part assemblies.

DEFLECTION MEASUREMENTS

Taken Electrically; Read on Inexpensive Meters

IN THE form of a hermetically-sealed electrical unit which translates minute deflections or pressure variations, applied to its plunger, into linear changes in its d.c. output voltage, a new deflection pick-up is said to be accurate even under unfavorable conditions. Readings are obtained in the range of 0.0005- to 0.1-inch movement of the plunger and reliable response up to 100 cycles per second is reported.

This Stevens-Arnold pick-up, with an output of 75 millivolts and an internal resistance of less than one ohm may be connected directly to standard indicating instruments of a type that are rugged, inexpensive, and portable. Pick-ups may be connected in parallel.

The combination of a pick-up and an indicating voltmeter may be used to obtain remote indications as an



Hermetically sealed measuring unit

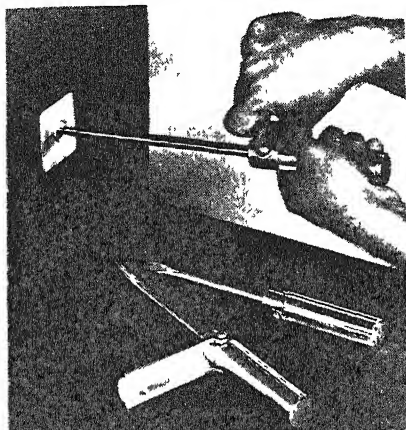
electrical micrometer, or for measurements of force, acceleration, pressure, or deflection.

Vibration, temperatures up to 300 degrees, Fahrenheit, or immersion in water, are said not to influence the instrument. Power supply may be 115 volts a.c. or an 8, 12, or 24 volt battery.

SCREW DRIVER

*Gets Extra Twist
from Power-Arm*

A POWER-ARM on a new triple-purpose screw driver gives extra power to unlock rusted screws and makes possible the pressure needed to tighten screws



Attached arm gives added power

firmly. With the power-arm folded back into the handle, the tool, labeled Tuffy, becomes a standard type screw driver, with an aluminum handle and a plated drop-forged steel blade.

FLOOR MATS

*Produced in Colorful
Synthetic Rubber*

SYNTHETIC rubber floor matting for theaters, hotel lobbies, office buildings, elevators, apartment houses, and other floors is now said to match the quality of pre-war mats made of natural rubber. Produced of GR-S rubber, by United States Rubber Company, the mats are colored black, maroon, red, white, green, blue, yellow, and salmon.

The mats are made with conventional corrugated or pyramid surface with or without perforations, and they also may be imprinted with special monograms or patterns to blend with various decorative schemes.

GLAZED COATING

*Increases Life of
Furnace Refractories*

A REFRACTORY coating which is applied to refractory brickwork or plastics refractories by paint brush or spray gun, is composed of high-fusion clays and metal oxides combined in oils. Known as Brickseal, it fuses under heat to form a highly-glazed, monolithic protective coating over the entire refractory structure.

Available in four grades to suit vari-

ous operating temperatures, Brickseal practically eliminates cracking and spalling of brickwork, stops infiltration of outside air, greatly simplifies the removal of slag and clinker and, by reflecting heat back into the furnace, definitely increases firing efficiency.

Suitable for protection of oil-, gas-, or coal-fired equipment, this coating, made by Brickseal Refractory Company, has been used in all types of boilers, incinerators, industrial heat-treating furnaces, and similar high-temperature equipment.

RUBBER-COATED WIRE

*Used in Baskets
Which Protect Contents*

A BASKET designed to safeguard potatoes against bruising was announced recently as a post-war product for the farmer.

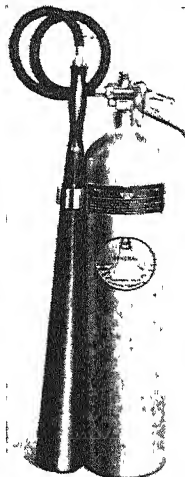
The basket, developed by United States Rubber Company, is made of steel wire coated with rubber and cushions the potatoes against bruising when they are thrown into it during field harvests. The rubber also protects the metal against corrosion. Open construction of the sides and bottom of the basket prevents collection of debris inside. It weighs three and three-quarter pounds and holds five-eighths of a bushel.

FIRE EXTINGUISHERS

*Using Carbon Dioxide Are
Available in Several Sizes*

CARBON-DIOXIDE portable fire extinguishers, in a complete range of sizes from two to 100 pounds and called CD-Sno Fog, are now offered for fighting fires in electrical equipment, oil, grease, and flammable liquids. Since the carbon

A number of desirable advantages are claimed for these new CO₂ fire extinguishers now available in a number of sizes ranging from two to 100 pounds



dioxide is a non-conductor, it is safe to use on electrical fires even while the current is on. Moreover it leaves no stain on clothing, equipment, or premises, and is harmless even when used around food.

The cylinder of the extinguishers is made of steel, with brass fittings. The discharge horn is of shock-resistant plastics construction. CD-Sno Fog extinguishers are the products of The General Detroit Corporation and The General Pacific Corporation.

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DUREZ CASTING RESIN. This technical discussion, in 12 illustrated pages, gives complete details on the use of the resin. Actual applications are shown and described. Uses covered include masking, dies, plating shields, models, jigs, and so on. *Durez Plastics and Chemicals, Inc., North Tonawanda, New York.—Gratis.*

THE INVISIBLE RAY is a six-page catalog containing information and prices on various black light kits, as well as lamps, bulbs, and fluorescent and luminescent materials. A comparative data sheet presents details on eight types of lamps and their principal uses. *Black Light Products, 450 East Ohio Street, Chicago 11, Illinois.—Gratis.*

ENGINEERING SERVICES describes the facilities offered by an independent organization of consultants and outlines the advantages that can accrue to industrial clients who have no engineering departments of their own or who have need for specialized advice and services. *Foster D. Snell, Inc., 305 Washington Street, Brooklyn 1, New York.—Gratis.*

OPERATING A SMALL BUSINESS. This four-page bulletin is essentially a bibliography which will serve as a guide to literature on all phases of the subject. The articles and books to which reference is made are described briefly but clearly. *Business Information Bureau, Cleveland Public Library, Cleveland 14, Ohio.—Ten cents.*

FORMING ARTICLES FROM EXTRUDED TENITE SHEETING is a 12-page booklet describing and illustrating the nine principle operations in the fabrication of sheet plastics articles and the equipment which may be used for the work. Part of the discussion involves methods of laminating and heat sealing. *Tennessee Eastman Corporation, Kingsport, Tennessee.—Gratis.*

YOU AND THE RETURNING VETERAN. This 40-page illustrated booklet, printed as a guide for foremen, discusses the important phases of industrial readjustment from the standpoint of the vet-

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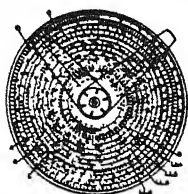
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IN THE following article Patrick A. Driscoll, Lima, N. Y., who went from "A.T.M." to a job as experimental lens maker in the Eastman Hawk-Eye Works in Rochester, tells how to furnish your wife with grounds for divorce for cruelty by casting metal lens or mirror grinding tools in the home kitchen, using the lost wax process.

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Into the life of every amateur optician there looms, at some time or other, the specter of the iron grinding tool. Requiring a lathe and attachments to cut its convex or concave radii, the iron grinder becomes a thing of complex machining to the average basement glass addict.

As a fellow "TN," suffering from lack of machine shop facilities, I wish to present an alternative solution to the production of the iron grinder. This requires a job of casting. The method is not claimed as new by the writer, but its application toward solving the amateur telescope maker's difficulties is original. We shall cast our grinders in zinc, and the process used is termed the "Lost Wax Method."

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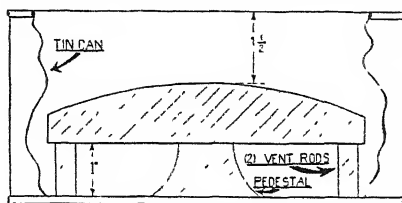
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- Rotating spindle (temporary)
- Glass gage of the desired radius.

We shall assume that a grinder is needed for a 6" (152 mm) mirror. The grinder should be 5/4 of the mirror diameter or 7 1/2" (190 mm), but if the worker prefers the equal-diameter mirror and grinder, let him proceed on that basis. [The philosophy of the 5/4 grinder was explained by Driscoll in the October, 1945, number.—Ed.]

The glass gage should be made from thin glass and as close to radius as possible.

To begin, the paraffin should be melted in a container about 1/4" larger than the grinder diameter desired. After it cools, apply heat around the outside of the can until the block drops out. The aim now is to shape this paraffin block into an exact model of the grinder we are to cast.

At this stage, we must have a rotating vertical spindle. This can be a temporary setup and does not have to be elaborate or complicated. The spindle speed should not be much over 100 r.p.m.—slower if possible. Here the amateur who possesses a polishing machine can leer with satisfaction. The spindle should have a flat, horizontal metal surface attached and on this we place our wax disk. We warm the spindle table, center the disk and allow



Drawing by E. F. Lindsley after the author
Molding a tool by the lost wax process

it to cool. Now with a sharp knife we *scrape*, not cut, the disk roughly to curve and check the radius with the gage. When the disk is close to the gage curvature, we abandon the knife scraper and to finish the disk to curve we use the gage itself as a scraper. With the spindle rotating, we hold the gage to the surface of the disk and shave off all irregularities.

We have now produced a grinder, modeled in wax to exact curvature—in other words, a pattern.

Now our large tin can comes into action. It must be at least 2" larger in diameter than our pattern. The pattern is mounted on a wax pedestal, two 3/8" wax rods are attached, and the whole is placed on the bottom of the can. See the illustration. The can bottom is then heated *locally* to adhere the wax to the metal and prevent shifting of the pattern. To forestall tipping, be sure that the pedestal and rods are of equal length. The next step will be making the plaster mold. Mix ordinary plaster of Paris thoroughly to a consistency that will just allow it to run slowly out of the mixing pan. It must not be putty-like. It must not be watery. Mixing and pouring must be completed in one minute. Time and plaster wait for no man.

Pour this mixture into and around the wax pattern until every nook and cranny is full and the pattern is covered with plaster to a depth of at least 1 1/2". Allow the plaster to set for 48 hours in a warm room. Do not try to hurry setting by using excessive heat at this stage.

With the mold firmly set we can now invert it and remove the bottom of the can with one of the new-fangled smooth-cutting can openers. The mold is now placed, pedestal end down, in a large pan. The mold must be placed on three blocks to keep it at least 2" up from the bottom of the pan. Be sure that none of the blocks covers the pedestal or the ends of the wax rod. Place the whole setup in the kitchen oven and bake it at 350°F until all the wax has melted and run out. Continue to bake it until certain that all moisture has been driven out of the plaster. As a test, hold a cold metal surface to the hole in the plaster. If moisture collects on the metal, continue to bake until dry. Remove from the oven and allow to cool to room temperature.

We now have evolved a plaster of Paris mold having a pouring spout and two vent holes to relieve trapped air in casting.

Zinc is recommended as a casting metal because of its low melting point and its advantage over lead in point of hardness, but the home optician may substitute lead if he desires. The difference in price will be negligible. Lead will have the drawback of retaining particles of emery or Carbo in rough grinding that may cause trouble in the fine grinding. To the amateur who has access to large quantities of lead, we say use it, making a new mold and casting a grinder for each size of emery. Here again, as was stated here last October in an article on the hand-lever type of machine, may I mention that, by machine, 180, 500, and 1200 emery are all the sizes required to produce a perfect surface for polishing. Finer sizes will tend to scratch when used with a metal polisher.

Place the plaster mold in the oven and heat slowly until it is fairly warm (200°F).

To ascertain the amount of zinc needed, weigh the paraffin model and multiply by 12 or 13.

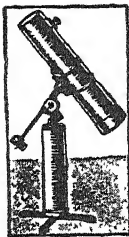
Melt the zinc on a gas flame and skim off impurities.

With the warm mold resting firmly, pour the molten zinc *deliberately*, but do not stop until the mold is full and zinc is expelled through the vent holes. Allow to cool naturally, until cold.

Cut the rest of the tin can away from the plaster and then attack carefully with a hammer. Out of the cocoon will emerge a perfect metal grinder having a pedestal and two rods attached. Saw these off and the flat back can then be drilled and tapped for any type of plate or driving stud the worker may decide on.

I have purposely outlined the production of a flat-backed grinder to simplify the job of casting. The amateur with a flair for complications can cast this grinder with its spindle-fitting at-

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tachment in one piece, if so inclined. Having turned my own kitchen into a foundry at one time or other, and knowing the reaction of the better half, may I wish you luck.

THE MANUSCRIPT of the above was sent to Dr. D. Everett Taylor, Willimantic, Conn., with an invitation to comment upon it. He replied: "This casting method—wax—is, as you probably know, the fundamental of the precise process in making dental inlays. Either Ransom and Ransome (Toledo, Ohio) or Kerr Dental Manufacturing Co. (6081 Twelfth St., Detroit, Mich.) dental inlay investing compound would be even more accurate than plaster of Paris, causing less distortion from expansion or contraction and remaining unchanged in high temperatures (2000° F), and the cost would not be prohibitive. If plaster of Paris is used, the addition of 30 to 50 percent sand would improve the mix."

He further offers as a substitute for zinc, lead 1 tin 1. bismuth 1, having a melting point 250°F, where that of zinc is above 700°F; contractibility, 0.00066 where zinc's is 0.01366; hardness, 0.042 where that of zinc is 0.018; brittleness, 7, zinc, 5. "This combination," he adds, "is attractive; with it the melting point is greatly reduced, the contraction is reduced to about one twentieth, and the hardness is more than doubled. The brittleness is increased somewhat, but, as I see it, the added brittleness is desirable rather than the reverse."

ONE AMATEUR to whom Driscoll's article was shown asked, "Isn't this a lot of work to make a tool?" Looked at in the light of work alone, it is. Telescope makers, being philosophers, don't look at things in quite that light. You might say, "I've always wanted to play with that old lost wax process and making a tool provides a good excuse, with the tool itself thrown in free." As Haviland says in "A.T.M.A.", what is a hobby if not to murder time—every moment of which is enjoyable.

URGENTLY, readers of this magazine often prod its book sales department to obtain for them second-hand copies of two famous old books that are out of print—Webb's classic "Celestial Objects for Common Telescopes," which went through seven editions after the first in 1859 (the seventh dates 1898-99), also Barns' "1001 Celestial Wonders," published 1927 and 1929 and patterned on Webb. It is probable that these requests come from readers who have only heard of their fame, since they are listed in numerous other books, but who have had no opportunity to inspect them.

Today the nearest substitute for Webb or Barns is "Norton's Star Atlas." Told this, readers ask "How near?", and think, "Wish I could see all three side by side and decide for myself."

Your scribe, one of whose many vices is a habit of haunting New York's numerous second-hand bookstores, has come across Webb but once, Barns never. Recently a fifth edition of Webb,

brought up to 1900, was picked up. With it, Barns, and Norton spread out side by side it is thus possible to give the reader a comparison of these three. This particular three are singled out from other books about the stars for one specific feature, their main feature—they contain extensive lists of show objects for users of 2" to 6" and larger telescopes equipped with setting circles; lists prepared to facilitate systematic survey of these sights such as double stars, variables, nebulae, and clusters.

It is true, the Ephemeris contains star lists with coordinates but not arranged as described and not nearly so useful to the amateur.

Webb's book "has done more to introduce the possessors of telescopes to the remarkable objects in the heavens and to create observers than any book ever written." This was said in the *Monthly Notices of the Royal Astronomical Society* in 1886 when Webb died. It is still true in 1946.

All three books being similar, what are the differences? Not much in presentation. Typical examples—same object, *sigma Cassiopeiae*:

Norton: R.A. 23, 56 4, 55 29; 5.4, 7.5, 327°; 3" .1. Grand low power field.

Barns 235455; D.54.—7.5; sep. 3" Teeming with jewels.

Webb. XXII h 53.9 m; N.55° 12'; 5.4, 7.5; 323.5; grn.v.bl. wh., tawny. Glorious low-powered field.

Thus, Webb's descriptions are a little more detailed.

Lesser differences: Norton contains star charts, so does Barns, Webb contains none. Norton is large—9" by 11 3/8"—Barns and Webb are pocket sized. Norton's data are for Epoch 1950, the others earlier.

The chief difference is quantitative. Where Norton lists about 500 show objects and Barns about 800, Webb lists 3177. Of this excess a large part consists, however, of doubles, an emphasis perhaps reflecting Webb's preoccupation with doubles due to his remarkable eyesight. Average observers are seldom equally preoccupied with doubles.

Webb therefore is a book to seek after the hunting in the available Norton has been exhausted, a book for the advanced amateur. For such, it is a treasure.

Lowell's three Mars books, "Mars" (1895), "Mars and its Canals" (1896), and "Mars as the Abode of Life" (1908), all out of print, are only medium rare—in the five-dollar class at second-hand.

"The Splendour of the Heavens" is rare—in the thirty-dollar class. Goodacre's "The Moon," not an old book (1931), is rare and in the same cost class, at second hand and, even then, virtually unobtainable. We know of an amateur who has searched far and wide for it for several years, advertised for it, been ready to give his fortune for it, yet without result. Recently, a small cache of brand new copies has been located where it was hidden away and forgotten during the war and they can be had without sacrifice of fortune—provided they are still there when we transmit your order.

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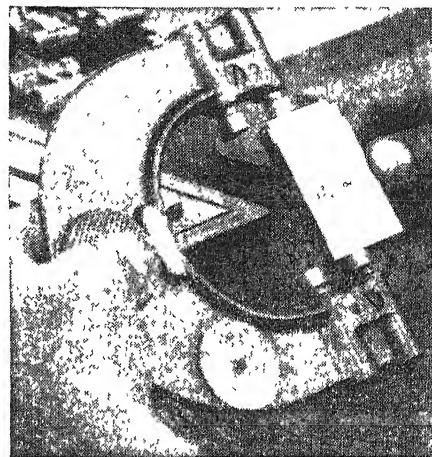
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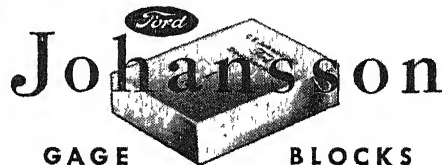
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GAGE

BLOCKS

50 Years Ago in . . .



(Condensed from Issues of June, 1896)

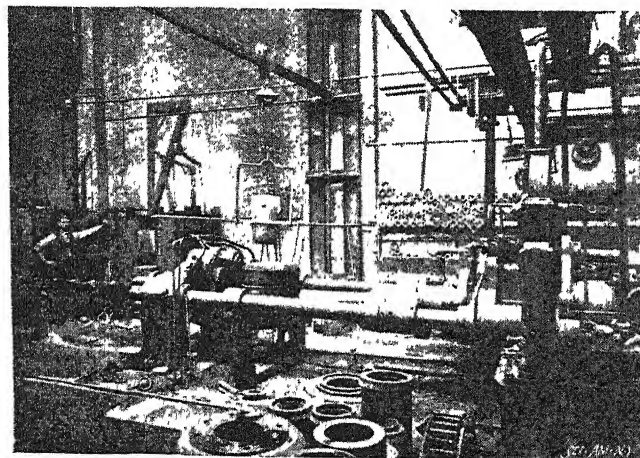
FLUORESCENT LIGHT — "The Edison fluorescing lamp produces light at the rate of 0.3 of a watt per candle power. When this is compared with 3 watts per candle power for incandescent lamps, and $\frac{1}{2}$ watt per candle power for arc lamps, it will be seen that there must be great economy in the fluorescing lamp."

RAIL JOINTS — "The great increase which has taken place in late years in the weight and strength of steel rails on trunk lines has made the problem of providing a strong joint a much simpler matter than it was in the days of the old fifty pound iron rails. But though the difficulties have been lessened, they have not been removed, and any analysis of the labor expended by a section gang upon a stretch of first-class track laid with one hundred pound steel rails would show that even here a large proportion of it was devoted to 'keeping up the joints.'"

LATHE — "An automatic copying lathe with automatic screw feed has been designed for turning from patterns all kinds of irregular shapes, such as spokes, neck yokes, singletrees, hammer, hatchet, pick and ax handles, shoe lasts, gun stocks, and other similar wooden articles. . . . The pattern which guides the path of the cutter head and governs the shape of turning should be an exact duplicate of the shape desired to turn, but the size of the article turned may be varied, either larger or smaller, from the same pattern."

AUTO RACE — "The Cosmopolitan Horseless Carriage Race was run on May 30, the winner being Charles E. Duryea, of Springfield, Mass. There were nearly thirty vehicles entered for the race, but on the morning of Decoration Day only six appeared to compete for the prize. Four of these belong to the Duryea Motor Company, Springfield, Mass., one was the Booth-Crouch carriage and the other was the Roger carriage, a French invention. The winner covered 13 miles in one hour, five minutes, and 42 $\frac{2}{5}$ seconds."

EXTRUSION — "The invention of Mr. Alexander Dick deals with all kinds of metallic sections, by forcing metal heated to plasticity through a die under hydraulic pressure. . . . It is true the principle of extrusion has been applied to the production of continuous lengths of leaden pipe and wire, and of leaden rods for the manufacture of small arm projectiles; but in the present case the metal is operated upon at a very high temperature, that of plasticity, or about



Producing metallic bars by extrusion

1,000 degrees, F. The process consists in placing the heated metal in a cylindrical chamber, at one end of which is a die. Upon pressure being applied at the opposite end, the plastic metal is forced through the die. . . . The edges of the openings in the dies are beveled, so as to give free access to the metal under pressure and to more perfectly condense it. The metal is forced out of the container through the die by an 18 inch hydraulic ram, working under a pressure of 4,480 pounds per square inch."

LAKE STEAMERS — "The shipyards of the Great Lakes had ninety vessels of various classes and dimensions under construction when the season opened this spring. . . . Nearly fifty of the new boats are to be of steel, which is now supplanting wood for all vessels of large size."

INVENTORS — "It is unfortunate that the person who claims, or is accorded by the public, the title of inventor should be popularly regarded as possessing powers which border on the miraculous; for, as a matter of fact, the most successful inventors have ever proved to be men of a practical turn of mind and of clear vision, who loved to pursue their investigation on logical lines, laying the foundation broad and firm as they proceeded; men who were marked above everything else by unwearied patience and perseverance that was unconquerable."

ACETYLENE — "It is stated that acetylene is being tried in some of the tram cars in Paris, and with promising success. . . . As the lighting power of acetylene gas is something like fifteen times that of coal gas, the cost is stated to be less than that of illuminating the cars by petroleum."

POWER GENERATION — "One of the novel electrical developments of the West has been the operation of electric lighting plants by means of artesian wells. The latest of these is at Chamberlain, S. D. In the Chamberlain plant, the water impinges on buckets arranged radially on the rim of a well known type of Western wheel. This wheel is mounted on a shaft which carries a large driving pulley, and the pulley belts to a five hundred incandescent light alternating current machine."

100 Years Ago in . . .



(Condensed from Issues of June, 1846)

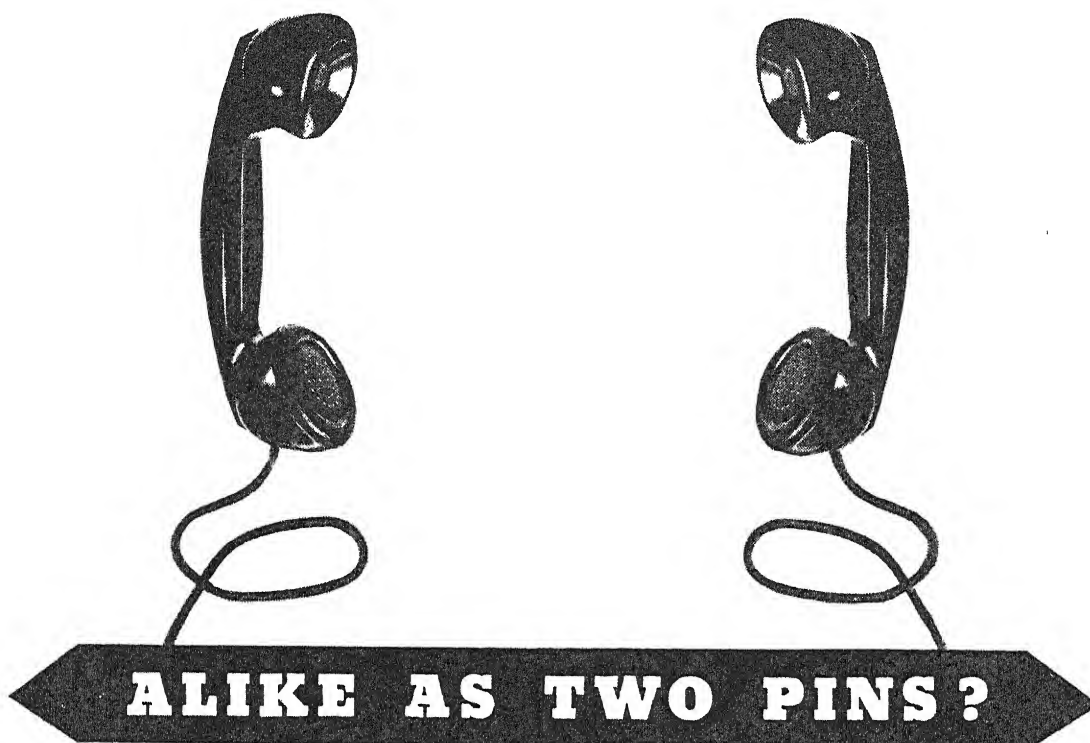
CUT-OFF — "A circular piece of common thin iron plate or sheet iron, being adjusted in a lathe, or by other means put into a violent rotary motion, will readily cut off a file, a cutting tool, or tempered steel spring, without drawing or reducing the temper."

WIRE PROTECTION — "The Legislature of Connecticut has passed an act for the protection of the telegraph within that State, and imposing a penalty of a heavy fine and imprisonment on any person who shall injure the line."

RAILROADS — "Several of the great lines of railroad in France are advancing with great rapidity, and portions of them are opened from time to time for use."

FIREPROOF — "A store with walls of brick or stone, rafters and beams of iron, a roof and floors and ceilings of iron and tin, would be in no danger of fire without, and very little from within."

NIAGARA — "It appears that a motive power of the single cataract of Niagara would be sufficient to move all the artificial machinery of the earth."



Yes, or alike as two telephone handsets made by the same process. Yet, pins or handsets — no two could ever be made exactly alike. Dimensions, weight, performance—all vary every time due to variables in manufacture. How can these variables be controlled?

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Western Electric, manufacturing branch of the Bell System, applied the new science to its large-scale production. In war, it was used by industrial and government agencies of the United Nations in establishing and maintaining standards for military matériel. A Quality Assurance Department, a novelty back in the nineteen-twenties, has come to be indispensable to almost every important manufacturer.

Scientific quality control is one of many Bell Laboratories' ideas that have born fruit in the Bell System. The application of mathematics to production helps good management all over the industrial world — and furthers the cause of good telephone service.



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Previews of the Industrial Horizon

WOOD FACES TROUBLE

OFTEN dealt with in the pages of Scientific American have been the various aspects of wood production and use. Right now it appears that wood faces a two-forked impasse. First is the all too familiar cost of production *versus* price control. But in the long view this must be considered as a passing phase. Far more important is the second fork. Growth. In 1945, for example, almost twice as many board-feet of lumber were cut from American forests as were grown. Obviously such a situation cannot continue for very long. Of course, the wood industry in general is completely familiar with the facts of the case and is doing something about it. But what is being done is not by any means enough. More industrialists must realize the importance of wood in our national economy, and add their strength to adequate plans for the restoration and perpetuation of our forest resources.

Above all, wood must not be thought of simply in terms of lumber. Wood offers a vast storehouse of raw materials for a number of industries other than those concerned with building materials. Pulp and paper come next to mind, but then there are such other diversifications as textiles and textile sizings, plastics, dyes, insect repellants, perfumes, resins, essential oils, gums, alcohols, sugar, and a thousand and one other materials for the chemical and allied industries.

Faced with even this abbreviated list of wood products, the problem looms large. Our forest lands are far from producing their maximum yield. Our research laboratories have only scratched the surface of the potentialities of wood. Our forests can and must become our largest source of raw materials for the greatest number of industries. But they can reach that goal only by intelligent application of scientific principles of adequate reforestation.

This subject of reforestation is one that has been bandied about for generations. Now the limit is approached. An understanding has been reached of the importance of the forests of the United States, but all too little has been done about it. Many industries, old and new, depend on wood. If for no other reason than for their contribution to these industries, the forests of the nation must be put in shape for maximum productivity.

THREAD DESIGN

UNDER the above title was published an item on this page in our February 1945 issue. It was concerned with the necessity for standardization of screw threads on an international basis. Now, with the war over, this industrial problem remains as large as ever. During the war, production of many items was hindered by the differences between British and American standards for threads. But now something is being done about it. As the result of months of technical effort on the part of national engineering committees, a working foundation has been laid for unification of the basic screw threads to be used by industry in the United States, Canada, and England. The new screw-thread form, paving the way for closer international unification of industry, retains the best features of former standards. The recommendations of the engineering committees should be adopted by the national standardizing bodies of the countries involved. Screw threads may seem trivial in themselves; actually they are of the utmost importance to industry.

LIQUID METAL

MERCURY, unique among metals because it is liquid at normal temperatures, has a future as bright as its own surface. Two recent developments lead the parade. One of these is the mercury dry cell developed for war uses and now being groomed for exploitation in hearing aids, portable

By A. P. Peck

radios, and other compact electronic devices. The other is the so-called mercury clutch for fractional-horsepower electric motors that gets such motors up to speed with minimum current consumption and reduced wear and tear. The clutch holds promise in such applications as washing machines, refrigerators, vacuum cleaners, and similar devices.

Then, there is the use of mercury in electric switches, fluorescent tubes, pharmaceuticals, fungicides, wood preservation, mercury-arc rectifiers, and so on. True, the liquid-metal industry seems to have lost a big market in anti-fouling marine paints to the plastics industry, but a new mercury-copper combination for this purpose bids fair to recapture at least a large part of the lost business.

In any event, mercury production is rising, new applications are being found for it; the potential supply appears to be practically unlimited; and its material peculiarities lend themselves well to industrial investigation.

"WHEN CAN I GET ONE?"

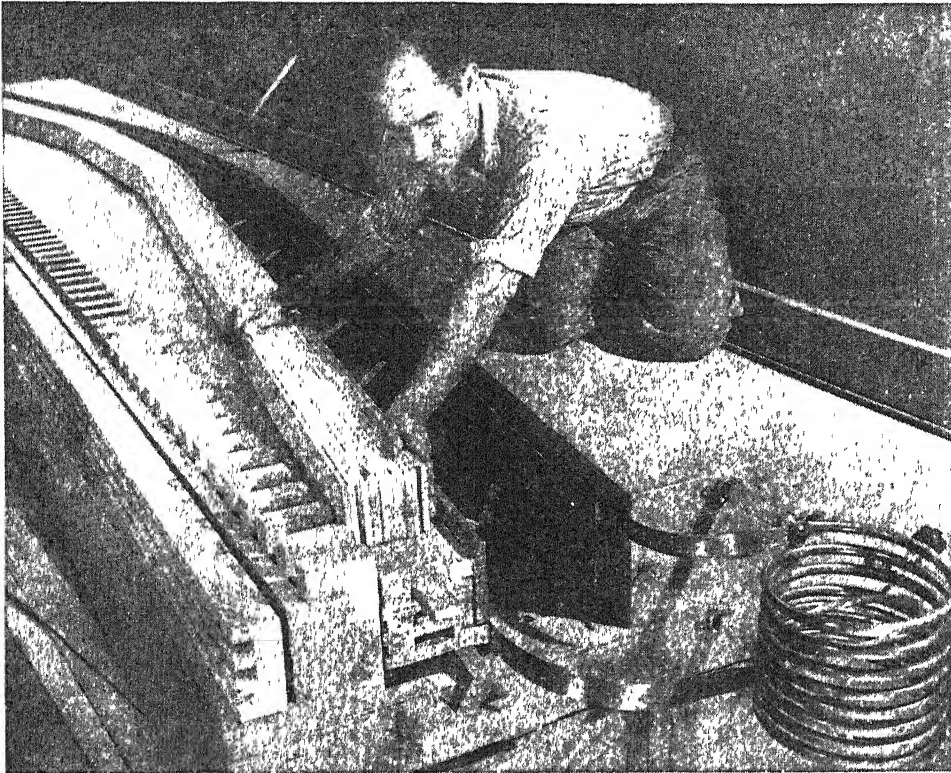
TREMENDOUS indeed was public interest in private planes exhibited recently at the National Aviation Show (New York); hundreds of orders were placed for various types of planes and the most-asked question on the part of buyers and would-be buyers was "When can I get one?"

Whether the favorable acceptance of the models displayed at the Show can be accepted as a barometer for the future of personal planes is something that only time can prove. But there is no question about the fact that private flying is going to expand rapidly in the near future and that one of the big fields for small planes is going to be their use by industry. Already a number of industrial organizations own ships and use them to save time for their executives who must travel long distances between plants or to conventions and the like. This use of non-commercial planes is and will continue to be a solid backlog for aircraft manufacturers. It does not depend upon thrill-seekers, but rather upon the inherent values of aviation itself.

On page 252 of this issue, Dr. Alexander Klemm gives essential and pertinent facts about personal planes. Future articles by Dr. Klemm will take up other aspects of private flying so as to present to our readers a complete and unbiased view of the advantages and disadvantages of this most modern form of transportation.

FOR FUTURE REFERENCE

By 1965 cork oaks being planted in the south and south west should be producing; they represent intensive efforts to establish an age-old industry in the United States, making this nation independent of the rest of the world for its supply of cork in all forms. . . Steam generators, for use with oil or gas and ranging in size from five to 200 horsepower, are available in completely assembled units; they can be in full operation within a matter of hours after arrival at the plant. . . Magnesium, once considered a flammable metal useless for applications where intense heat is generated, is now being produced in alloy form that will resist the elevated temperatures found in gas-turbine compressors; it is corrosion resistant and has strength-weight properties superior to commercial aluminum alloys; the metal is still in the experimental stage. . . An Incentive Division of the Office of Domestic Commerce has been set up to study bonus, incentive-pay, profit-sharing, and other systems used by industry to promote production; its own greatest output will undoubtedly be red tape.



Laminated spar flange for a Fairchild airplane being removed from press. Here high-frequency energy simultaneously molds the wood and sets the glue quickly

ELECTRONICS

Conducted by KEITH HENNEY

Joints In A Jiffy

THE HITHERTO baffling problem of getting a uniform degree of heat quickly to all of the glue lines in a piece of furniture or a thick laminated-wood section has been solved by harnessing the electron. Electronic heating, as used for wood, goes by many other names—radio-frequency heating, diathermic heating, dielectric heating, and high-frequency heating—all referring simply to the use of high-frequency alternating current to generate heat.

Its application entails the use of two plates or electrodes, between which is placed the wood to be heated. A high-frequency alternating voltage is applied to the plates. At one instant the top plate is electrically positive and the high

electrical stress in the wood tends to move the molecules in one direction. On the next electrical alternation, the lower plate is positive and the molecules are urged in the other direction. For a frequency of 30 megacycles, this is repeated thirty million times per second, and the friction between the molecules re-

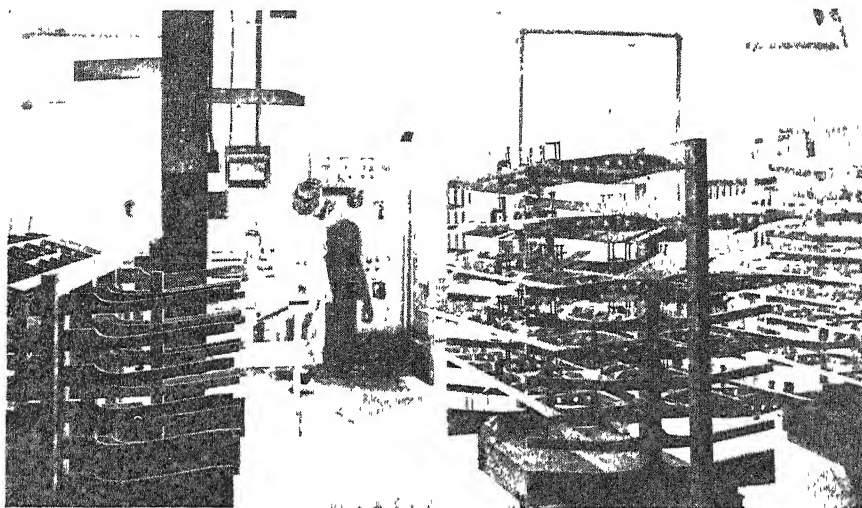
sults in heat. The higher the frequency, the greater is the friction and the more heat generated.

Since the heat is generated in the wood itself, it is unnecessary to place the work in an oven. The electrodes are at relatively high voltage, however, and must be surrounded by a cage to protect the operator

Electronic Heating to Set Glued Joints Moves Wood-Products Assembly into the Mass-Production Class. Marked by Uniform Heat Throughout the Joint, High-Frequency Techniques Slash "Clamped-Up" Time, Cure Interior Glue Lines Without Danger of Over-Curing Near the Surface

By JOHN MARKUS

Associate Editor, *Electronics*



Use of 15-kilowatt RCA generator at Wurlitzer plant upped wing production to seven times former rate, cut curing time from six days to a mere matter of minutes

from electrical shock. Since the wood need not be touched by the electrodes, it may be heated while moving on a conveyor between the electrodes, provided the spacing between the electrodes and the work is not too great.

Heating can be obtained either by a combination of low frequencies (on the order of three megacycles) and high voltages (15,000 to 18,000 volts) or high frequencies (up to 30 megacycles) and lower voltages (3000 to 4000 volts). The selection of the proper combination of voltage and frequency is a complicated one. The thinner the piece being processed, the lower must be the voltage to prevent arcing between the electrodes. Also, for a given amount of heat, a four-fold increase in frequency will reduce the required voltage by half.

BONDING METHODS—To see why electronic-bonding techniques have been so important to develop, it is helpful to review the three classes of bonding materials or glues which are in general use: casein glue, urea-formaldehyde resins, and phenol-formaldehyde resins. The first two classes will set at room temperature in about six to eight hours, although this time can be reduced by the application of heat. The third class, and the most durable, requires either room temperature coupled with a long setting time (measured in hours) or high heat of 200 to 280 degrees, Fahrenheit, for the rapid setting (measured in minutes) necessary for production.

There are two general methods of applying heat to a glue line. The first—non-electronic—is to apply a heated platen to the surface of the wood and allow the heat to soak in from the outside. The second—the electronic process just described—

causes the wood to heat uniformly throughout its thickness.

In the furniture industry, curved-laminated sections for radio cabinets, pianos, and similar pieces of furniture can be assembled with electronic heat, and made lighter, stronger, and cheaper than when present methods such as slotting, steaming, bending, and reinforcing of a solid piece of wood are used.

An electronic spot-gluer, resembling an automatic pistol, has recently been developed for temporary spot gluing, or tacking, of veneers to hold them in place while laying them up on a mandrel to form curved plywood assemblies. This unique device applies high-frequency currents over a small area of the topmost veneer to form a temporary bond by partially setting the glue between the veneers at each point to which it is applied. Spot-gluing eliminates the need for the tacks or staples ordinarily used, which leave holes in the veneers and must be pulled out and re-set as each sheet of wood is added.

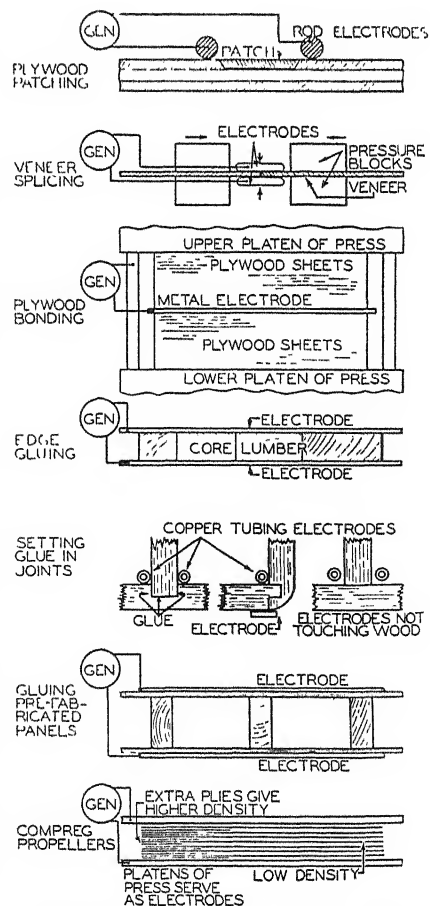
FURNITURE—Thus far, the principal application of electronic heating in the furniture industry has been edge gluing to make core lumber—the name given to the multiple pieces of solid wood placed between two pieces of veneer to make such large flat surfaces as desk tops, doors, chair seats, and table tops. The two electrodes are placed above and below the stock. Power is applied for five to 125 seconds, giving a glued board that can be taken out immediately and banged on the corner of a bench with assurance that any failure will be somewhere else than at the glue line. This obviously makes for an extremely rapid and efficient production process, readily adaptable to continuous production of core lumber.

When using high-frequency heating, it is not necessary to set up all the glue area. If, for example, 30 percent of the glue face area is set up in the machine, this will usually be sufficient to hold the pieces of stock together without further clamping. Then, a number of hours later, the remainder of the glue line will set up at room temperature and the finishing operation can follow.

Where production volume justifies the expense of setting up electrode fixtures and jigs for specific corners and joints in the article to be manufactured, high-frequency gluing can provide decided economies through increased production speed and consequent lower labor costs. Either contact electrodes or air-gaps can be used, but contact electrodes always provide the highest speed and efficiency if it is practical to use them.

The use of dielectric heating to set glue in the rounded corners of furniture is considerably faster than conventional slotting and bending, and requires no block to be glued and clamped overnight. Several 15-kilowatt generators are now being used to set laminated chair and table frames in this manner in about one minute.

In one application of high-frequency heating to the manufacture



Typical applications for curing glue electronically. Set-ups must be engineered for requirements of each job

• LOOKING AHEAD •

Timber sizes appear to be getting smaller; but the demand for wood products grows apace. . . Glue technology promises to fill the bill for making "big ones out of small ones".

. . . Fast electronic heating reduces time of setting from hours to minutes. . . Opens way to new fabricating techniques. . . Furniture, prefabricated panels, plywood, laminated timbers can benefit. . . No mystery—just applied electronics.

of bed foots and bureau tops, the saving per day was found to be \$160 for materials and \$112 for labor, due solely to the change to high-frequency heating. These figures constitute a total saving of \$68,000 per year, confirming the statement often heard that high-frequency equipment, if properly applied, will easily pay for itself in a year.

VARIED APPLICATIONS — Resin-impregnated and compressed wood is known commercially as Compreg. If resin-impregnated only, it is called Impreg. These woods found a number of war applications, one of which was the production of aircraft propeller blades which are reported to have a strength per unit weight in excess of that of steel.

The manufacturers of Compreg and Impreg envision considerable use of the material, particularly in the form of veneer, for such things as table tops and general furniture finishing, because it is extremely hard, almost impossible to nick, and relatively impervious to alcohol and other stains. Also, by using different lengths of veneer and pressing them between upper and lower platens that remain parallel, a material of varying density may be obtained. This enables the design of beams with varying strength to meet specific load conditions. In making wheels, propellers, and other products that will be subjected to centrifugal force, the low-density material is placed near the periphery and the strong high-density material at the hub. Electronic heating is particularly advantageous for uniform and fast setting.

While there has been little use for electronic heating by individual contractors in the fabrication of houses, a great deal of interest has been shown in such heat in the manufacture of pre-fabricated wall panels. These are normally made up of 3/16 to 3/8 inch plywood placed on each side of one by three

or one by four inch studs, the space between being filled with insulating material. The panels are made in various shapes up to about four by eight foot rectangles, and glue in joints can be speedily set from the outside by application of high-frequency energy through appropriately shaped and positioned electrodes. Uses of electronic heating for drying wood have been found, but only where the part to be dried is extremely small, such as broom handles, knife handles, and smoking-pipe pre-forms. Here—in contrast to large-scale timber drying—the path for the water to get out of the wood is short and the high-speed advantage of dielectric heating can be adopted with economy. Another application is re-drying the entire flitch in the production of fancy veneers, since the total moisture to be removed is less than 10 percent and the material itself is thin.

PLYWOOD—One lumber industry application that has begun to be successful is the use of dielectric heating for veneer patching. When a knot-hole or other imperfection is found in the top veneer, a piece is cut out of the top veneer surrounding the knot-hole. The piece is of exact shape to match pre-cut patch, which is then laid in place. The two heating electrodes are held side by side against the top veneer, and the current flows through the glue line in a very short time. With only a few hundred watts of power, such patches can be set in five to fifteen seconds.

The manufacture of plywood in

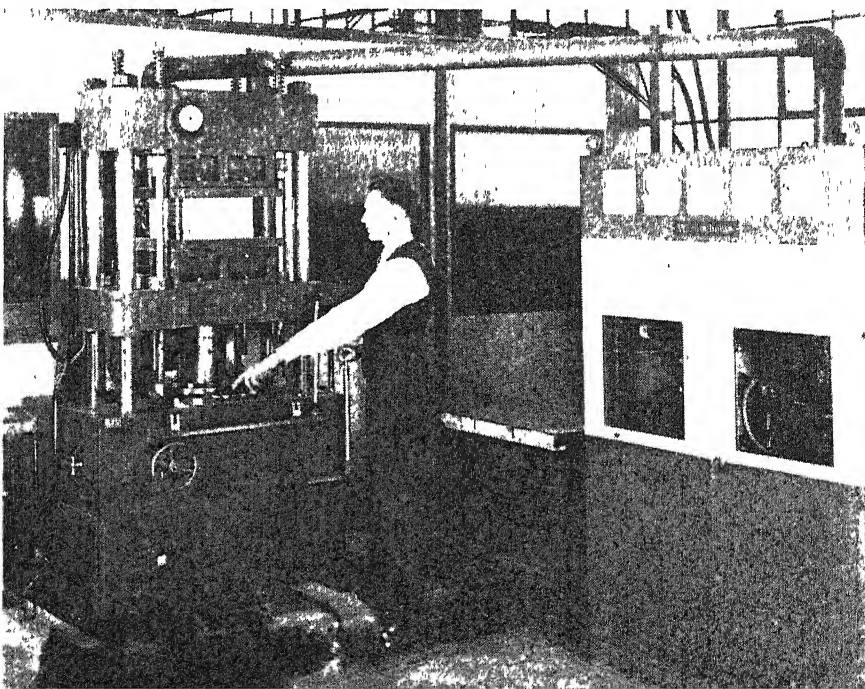
large batches has come in for considerable attention and at least one such installation in the United States has been in operation since 1942. Here, two batches of four by eight foot plywood, each batch one to two feet in height, are heated simultaneously with rather high-power generating equipment.

Considering the growing scarcity of large cross-sections of timber, and the inherent lack of uniformity of lumber, the more efficient production of plywood, bonded in minutes instead of days by the use of electronic heating, assumes tremendous importance. Plywood is uniform in quality throughout a given piece, eliminating the need for such large safety factors as are required when timber is employed.

Previously, it was uneconomical to produce sections of plywood thicker than about one inch because of the impossibility of effectively setting the adhesive in the interior before the resin near the surfaces became over-cured. With electronic heating, however, practically any thickness of plywood can be made with the assurance that all of the glue layers will be cured uniformly. As an example, 148 sheets of impregnated birch veneer have been glued successfully using a phenolic-resin adhesive.

High-frequency heating has been used extensively in the manufacture of aircraft wing spars, PT boat girders and ribs, boat keels, and other comparatively large items. The sandwich method is used and electrodes and presses 20 feet long are entirely practical.

Now, extensive use of electronic



Plywood press receives high-frequency energy from Westinghouse generator at right. Heavy sections may be bonded since heating is even through all layers.

heating is expected in the manufacture of pre-fabricated laminated girders and arches for auditoriums, aircraft hangars, and stages. Similar techniques were used during the war to make sections of wooden airplanes, skis, balsa-wood life rafts, lead pencils, and shuffle boards.

NOT MAGIC—There is no great mystery in using electronics to speed up the setting of glue lines and produce more durable wood products. However, the successful application requires the services of an experienced engineer who not only understands high-power radio equipment, but who has a thorough understanding of basic electrical engineering. In addition, he must understand the theory and application of bonding agents, wood technology, and the application of fluid pressure. In practice, once the operation is set up and the proper safety interlocks provided, the electronic equipment can be operated by a locally trained technician.

Electronic methods heat wood products and glues so rapidly that their use has in many instances reduced process time from hours to minutes. Production rates are increased and costs reduced, rejects are fewer, wear and breakage on molds and presses is lower, and less expensive molds can be used. Intelligent use of electronic heating can therefore be considered a valuable advance in wood-products technology.



RUBBER COOKING

*Time Reduced by
Electronic Process*

HEA T required for the marriage of molecules of raw rubber and sulfur during vulcanizing is produced electronically in a process now being



Rubber part, between disk electrodes, is vulcanized quickly and uniformly by electronic generator that changes 60-cycle line power to high-frequency power ranging up to 40,000,000 cycles

perfected by The B. F. Goodrich Company, that holds promise of revolutionizing the tire-making industry. Electronic heat makes the molecules join together in minutes instead of hours, at a lower cost and with more uniform product quality. The new technique has already been tried on a variety of rubber products, with heating frequencies ranging up to 40 million cycles per second, and in some instances curing times have been cut to one eighth that required by former methods

TRAIN SPACER

*Advises of Obstructing
or Overtaking Trains*

THE DISTANCE between two trains moving toward or away from each other, on the same or adjacent tracks, is indicated up to a maximum range of eight miles by a radio distance indicator called Radin. The system has already been tried by the Rock Island Lines, and a permanent installation has been made on their crack Golden State Limited.

This new electronic instrument utilizes the phase change of a radio signal with distance from a transmitter as a means of measuring distance. At the front and rear of each Radin-equipped train is a transponder. This unit sends out coded signals in response to a radio challenge from another train and converts corresponding signals from the other train into distance indications so that engineers of both trains know exactly how far apart they are. If the trains are approaching each other, knowledge of traffic schedules for that section of line would tell whether the trains were safely on different tracks. Radin was developed by Sperry Gyroscope Company.

TAXI RADIOPHONES

*Give Two-Way Communication
Even in Shielded Areas*

DEMONSTRATIONS of radio transmitter-receiver sets in Chicago taxis recently started cab companies scrambling to place orders for frequency-modulation equipment. The sets are designed for use in the 152-162 megacycle waveband allocated for vehicle two-way communication. One manufacturer, Galvin Manufacturing Corporation, has received orders from over 50 companies for an estimated total of about 500 cab radiophones, at a price of around \$500 per unit.

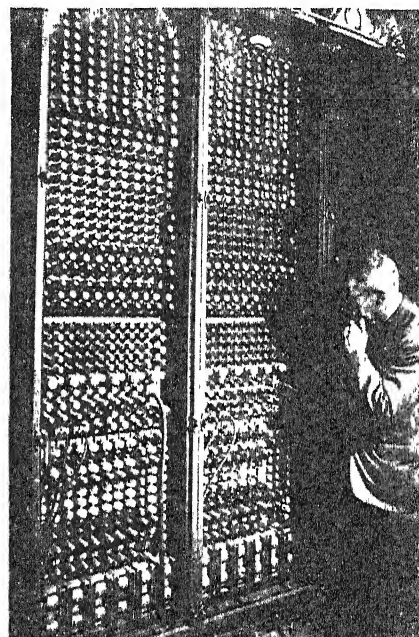
The demonstrations showed perfect reception within a 15 mile radius of the station—ample for coverage of practically any city in the world. Operation was also satisfactory in

places unsuited to ordinary broadcast-band sets, such as the steel-reinforced lower levels of sub-surface roadways and tightly screened railway station ramps

ELECTRONIC CALCULATOR

*Uses 18,000 Tubes to
Solve Complex Problems*

CAPABLE of solving scientific problems so complex and difficult that all previous methods of solution were considered impractical, an electronic robot, known as Eniac—Electronic Numerical Integrator and Computer—has been announced by the War Department. It is able to compute 1000 times faster than the most advanced general-purpose calculat-



Tubes are mounted in removable racks

ing machine built, and solves in hours problems which would take years on a mechanical machine. Containing nearly 18,000 vacuum tubes, the 30-ton Eniac occupies a room 30 by 50 feet. Originally developed to compute lengthy and complicated firing and bombing tables for vital ordnance equipment, it will solve equally complex peace-time problems in nuclear physics, aerodynamics, and scientific weather prediction.

Research laboratories of several industrial firms have expressed active interest in the machine. These include manufacturers of electron tubes, jet engines, gas turbines, and other types of engines. The first problem put into the machine would have required 100 man-years of trained computers' work but Eniac took only two weeks. Two hours of this was electronic computing time, the rest of the time was devoted to review of the results and details of operation.

Beryllium: Workaday Metal

Well-Established as a Practical Engineering Material, Beryllium has Shed its Cloak of Mystery. Expensive and Hard-to-Work in the Pure State, It Alloys with Other Metals to Provide Properties Otherwise Unobtainable. Main Use—So Far—is in Beryllium-Copper Combinations

By FRED P. PETERS

Editor-in-Chief, *Materials & Methods*

THE PRE-WAR "wonder metal," beryllium, is still the subject of considerable wondering. Many industrialists wonder if it's really a miracle material, harder than tool steel and nearly as light as magnesium—wonder if it will, therefore, take the place of all other hard and light metals. Some wonder if beryllium-copper, its most important alloy, will capture the markets for strong bronzes, alloy steels, and so on. Still others wonder if there's enough of the metal for all these uses, whether beryllium is any good at all, and if the price situation will change.

The answer to these questions about beryllium's present position and future possibilities may be found in its history and current applications. They show that beryllium has passed from the "rare earth" to the "important alloying metal" stage; that it is not a miracle or magic metal, but is an increasingly useful engineering material. Beryllium alloys mightily aided victory by serving in a number of highly critical war-application spots. Now, there is enough of it for all current uses and despite the unlikelihood of an early

drop in its price, beryllium can look forward to a bright and increasingly important future.

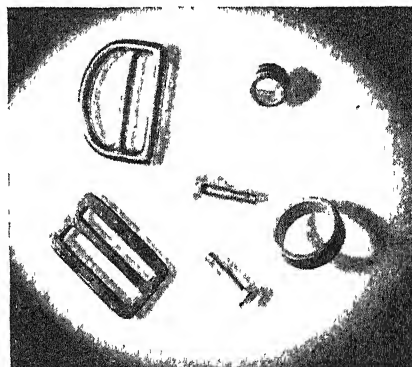
PRODUCTION — Beryllium was "discovered" by Louis Vauquelin in Paris early in the last century, and beryllium and copper were first alloyed in 1897. However, the commercial beryllium-copper alloys of today, and especially the use of heat treatment to achieve the exceptional mechanical properties characteristic of them, have all evolved within the past 20 years or so. Pioneers in the commercial production of beryllium and its alloys were Brush Beryllium Company, and Beryllium Corporation of Pennsylvania. Beryllium-containing alloys—chiefly beryllium-copper—in various fabricated forms are now produced by a number of additional manufacturers.

As late as 1941, beryllium ore production was only 2500 tons; by 1943 it was in the neighborhood of 6000 tons. Much of this ore production in 1943 was used to make 3000 tons of beryllium-copper; a recent estimate of present capacity for beryllium-copper production is approximately 10,000 tons.

Again, in 1935 the price of beryllium metal was \$200 per pound. Through production expansion, and because the copper-beryllium master alloy may be produced directly from the ores without having to make beryllium metal separately, the present price of the base alloy is down to \$17 per pound of contained beryllium. Fabricated beryllium-copper now costs upwards of \$1 per pound. But there seems to be no technological reason to predict a further lowering of the price in the near future.

Clearly, beryllium's future is closely tied to that of its most important alloy, beryllium-copper, which is now widely used for springs, diaphragms, electrical contacts, bearing bushings, non-sparking safety tools, gears, ball-bearing cages, plastics molds, and similar items. Yet there are other important, though "small tonnage," applications of beryllium metal, such as beryllium-aluminum, beryllium-nickel, and even beryllium-steels in either the fully established or "under-development" stage

BERYLLIUM METAL — Possessing a number of highly interesting properties, pure beryllium's commercial utilization is sharply limited by the great difficulty and expense of working the metal. It is, for example, the



Photographs courtesy
Instrument Specialties Company

Beryllium-copper forgings meet needs
for corrosion resistance, toughness

only stable light metal—density 1.84, as compared with magnesium's 1.74—with a high melting point. Beryllium melts at 2350 degrees, Fahrenheit, magnesium at 1200 degrees, Fahrenheit, aluminum at 1240 degrees, Fahrenheit.

Beryllium possesses an extremely simple atomic structure, so that the pure metal is virtually transparent to X-rays. This property has led to its use as the "window" in X-ray tubes and elsewhere in X-ray or diffraction apparatus wherever it is necessary to have a material through which X-rays will readily pass. The thin disks, strips, and other shapes

• LOOKING AHEAD •

Great strength at elevated temperatures is available in beryllium-alloys.

... Precision instruments can be made better with beryllium-alloy springs because of low "elastic drift". . . Specialized applications of various alloys are coming into use. . . New treatment methods can control hardness, strength, and elasticity. . . New markets opening up.

used for these windows would be virtually impossible to form out of commercially pure beryllium, but if the metal contains small amounts of titanium and zirconium, sheets 0.004 inches thick are easily produced which have good brazing properties and will hold a vacuum for several years.

Possible acoustical applications are indicated by beryllium's excellent sound-transmitting ability, which is reported to be twice that of aluminum or steel. Its great oxidizability at high temperatures, plus its affinity for other gases than oxygen, has led to its use as a "getter" in vacuum tubes. The cast pure metal looks like steel and is hard, corrosion-resistant, relatively brittle—and very expensive.

In conjunction with radium, beryllium is useful as the source of neutrons for bombarding U-235 to produce plutonium—one of the steps in the manufacture of the atomic bomb.

Finally, as a metallurgical-addition agent—aside from its uses as an alloying element in copper and nickel alloys and steels—beryllium serves in amounts from 0.005 to 0.05 percent to de-oxidize, de-gasify, and control the grain size of aluminum and magnesium alloys and to increase their corrosion resistance.

WITH COPPER—Beryllium-copper, the outstanding combination of the beryllium family, is today well established as an important engineering material. There is no more "mystery" or "magic" properly associated with it than there is with the common age-hardening aluminum alloys, the hardenable aluminum-bronzes, the heat-treatable steels, or any other alloy that displays an interesting combination of properties obtainable through heat treatment under known conditions.

Beryllium-copper, as commonly used, contains about 2 percent beryllium, ½ percent nickel or cobalt to aid in controlling grain size, and the balance copper. The alloy can be worked and fabricated in the soft or annealed state—or it may be formed in the cold-worked state—and then heat treated to give a combination of properties not available in any other material. Resulting tensile strengths in excess of 200,000 pounds per square inch make the alloy akin to hardened steel in mechanical strength. But beryllium-copper is much superior to steel in corrosion resistance and electrical conductivity, and is also non-magnetic. Its fatigue strength is greater than 65,000 pounds per square inch, a respectable value among all the engineering materials.

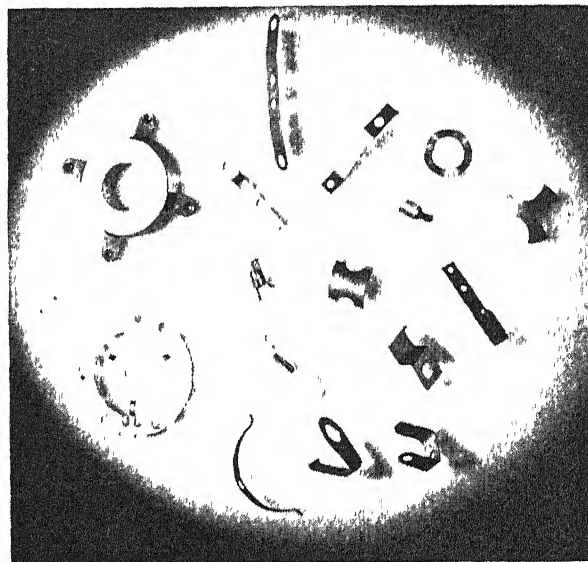
SPECIAL PROPERTIES—An unusual characteristic is the resistance to "elastic drift" possessed by heat-treated beryllium-copper. Drift is a

form of "cold creep"—actually the failure of a metal to return to its original length after it has been stressed within its elastic limit. Poor drift properties are detrimental to such products as calibrated springs, which should return to their original positions and dimensions after each stretching. Correctly heat treated, beryllium-copper shows the lowest drift of all commercial spring materials, and has therefore rapidly increased in use for fine instrument springs, diaphragms, Bourdon tubes, and like applications.

Where strength combined with great toughness is essential, as in special types of bearings and bushings, gears, spring shims and washers, aircraft gun mounts, cowl-flap hinges, ball-bearing cages, and similar locations, beryllium-copper offers, in many users' opinions, the best properties available among all the copper alloys.

Again, for electrical parts, beryllium-copper provides a combination

Springs of beryllium-copper will withstand stresses twice as high as are safe for phosphor-bronze springs. For optimum use of alloy's special characteristics, the heat-treatment must match specific applications



Unmachined impeller casting of beryllium-copper. Ability of this alloy to make sound, dense castings in intricate patterns is only now being recognized

of high conductivity—both electrical and thermal—strength and fatigue resistance at high temperatures, and excellent corrosion resistance. These properties have led to its use for high-strength current-carrying springs, vibrator arms, resistance-welding electrodes, circuit-breaker parts, and in other spots requiring very-high-conductivity copper alloys that must also possess high-strength. For uses such as these, copper-beryllium alloys containing only 0.1 percent beryllium are being studied and show real promise for future uses.

FABRICATION — Beryllium-copper has received most publicity as a wrought material, but the use of beryllium-copper castings is on the increase as materials-and-process engineers learn more about their ad-

vantages The alloy has excellent casting characteristics, giving dense, sound castings. When this is coupled with the high strength of the alloy after heat treatment, a product is obtained that often competes successfully even with steel forgings. Beryllium-copper castings, an addition to their impact strength and other favorable mechanical properties, are corrosion resistant and have high conductivity—advantages which recommend them over other materials for various special-characteristic products.

There is no standard heat treatment for beryllium-copper. For years, the traditional heat treatment was to anneal at 1400 to 1500 degrees, Fahrenheit, quench in water—this leaves the material soft and workable—and then to age-harden by heating for about two hours at 575 to 600 degrees, Fahrenheit. With such treatments, beryllium-copper developed good strength properties sufficient for most of its early uses and for many of its applications today. In recent years, however, study of the effect of heat treatment at different temperatures and times by metallurgists at Instrument Specialties Company, has shown that even better properties are obtained by age-hardening at higher temperatures for shorter times; for instance, 650 degrees, Fahrenheit, for 20 minutes or 700 degrees, Fahrenheit, for 12 minutes. It was also indicated that individually pre-determined cycles may be chosen for a given lot of material with a particular amount of prior working to produce maximum fatigue strength, minimum drift, maximum hardness, or special combinations of two or more properties. The heat treatment that produces the maximum hardness available in the material, for example, is not the same as the treatment that results in minimum elastic drift, so that, where feasible the hardening heat treatment should be selected according to service requirements of the product.

OTHER ALLOYS — Even stronger than beryllium-copper, and better for elevated-temperature applications, but not yet widely used commercially, is beryllium-nickel—nickel containing two to three percent beryllium. It may be heat treated to tensile strengths higher than 250,000 pounds per square inch and hardnesses of Rockwell C 53, with other properties comparable in many ways to those of beryllium-copper. It is considerably more expensive than the latter and thus is finding only specialized applications, particularly those requiring exceptional corrosion resistance or reten-



Aircraft engine bushings, machined from bars, support high unit loads

tion of hardness up to about 700 degrees, Fahrenheit.

The "beryllium-steels" are the most recent development in the beryllium field, with several companies actively investigating their high-temperature properties for gas-turbine and jet-engine use. One such steel, which contains 12 percent chromium, 8 nickel, and 1 beryllium, age-hardens to its maximum properties at 1300 to 1400 degrees, Fahrenheit, and is regarded as excellent for springs and other parts that must retain their strength at red heat.

* * *

ALUMINUM AUTOMOBILES

*May be Produced
by Spot-Welding*

ONE TROUBLE with making all-aluminum automobile bodies in mass production is that aluminum alloys will not stand the severe deep drawing needed to produce attractive contours. Therefore, instead of making large sections in one piece as with steel, it has been suggested that several smaller pieces be made and then assembled. A spot-welding technique has now been worked out to allow the successful joining of several stamped-aluminum sections, and a few auto makers have definite plans to bring out aluminum bodies in their next models.

TINNED STEEL

*Holds Paint Film;
Reduces Corrosion*

THIN TIN coatings on steel under paint are reported to protect against corrosion and perform the functions of a phosphate surface treatment. Some experimenters claim that they are easier and cheaper to apply than the phosphating. The tin coatings tested varied from ½ ounce up to

Aluminum-casting alloys—developed especially for precision castings—containing beryllium plus copper, and sometimes cobalt—0.2 percent beryllium, 3.8 copper, 1.3 cobalt, and the remainder aluminum—have recently been developed with high-strength properties coupled with unusual oxidation resistance and thermal stability.

Although not itself a metal, beryllium oxide fills an important part of the beryllium market. It is one of the best very-high-temperature refractories—successful uses at 3600 degrees, Fahrenheit, have been reported. It is also a good electrical insulator at high temperatures, with unusual resistance to thermal shock. Other uses for beryllium oxide include high-temperature crucibles and shapes, fluorescent-lamp phosphors, furnace linings, radio-tube filament-heaters, refractory supports for electrical heating elements, and so on.

In view of the vast amount of beryllium in the earth's crust and the increasing body of sound technical knowledge about the metal and its alloys that has in recent years replaced the "mystery" concerning them, it is reasonable to predict future applications and markets for these exceptional materials far greater than they currently enjoy.

2 ounces of tin per square foot, the latter giving a very superior protection. The tin is applied by electro-deposition. Such treatment may be found on future motor-car bodies, steel window frames, refrigerators, ranges, and steel furniture.

RIVALS OF URANIUM

*Promise More Radiation Energy
at Lower Cost*

KNOWLEDGE and developments concerning energy-radiating materials are expanding rapidly. Polonium, a pure alpha-ray emitter, is now available in quantities for scientific and industrial purposes. Suited for applications where effects due to penetrating gamma radiations must be avoided, it can be used in large quantities without danger to personnel. Polonium can be supplied in high purity as a solution and furnished co-precipitated with beryllium as an efficient neutron source. In addition, it is learned that lithium is at least theoretically able to yield two to nine times as much energy as uranium. Boron, a cheap element, could yield 25 percent more energy than uranium, according to some investigators.

Private Plane Prospects

With Many Design, Marketing, and Usage Questions Yet Unsettled, the Personal-Airplane Picture is Nevertheless Beginning to Clear. Industrial Users—Now Counted as the Best Market—Will Find a Wide Selection of Planes Adaptable to Nearly All Business Needs

By ALEXANDER KLEMIN

Aeronautical Consultant; Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

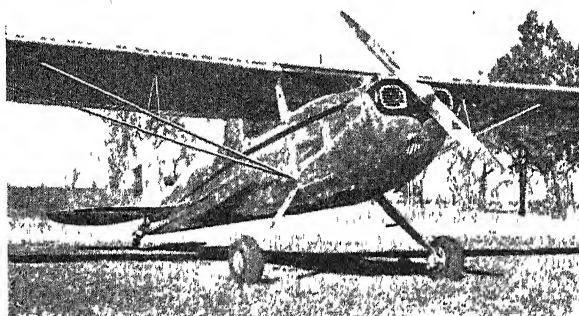
WHERE DOES private flying stand today? What are its immediate prospects? What equipment is available and what does it cost? What difficulties are involved? What service, direct and indirect, does private aviation offer American industry and business?

Many agencies, both governmental and private, have directed considerable research towards finding

encouraging. Parks Aircraft, a large mid-western sales-and-service agency, reports that the demand for private airplanes in the \$2000 to \$6000 bracket far exceeds the ability of industry to supply them in the next 24 months. Orders are coming in faster than new airplanes can be delivered, although plane manufacturers are already in excellent production Engineering and Re-

• LOOKING AHEAD •

Continued growth of "personalized" executive air travel. . . Private plane sales to enthusiastic "first-buyers" will peak, then drop back to a lower, but still good, level. . . Roadable planes, now in test stages, on market eventually. . . Majority of planes of conventional design for next four or five years. . . Then an infiltration of what the public hoped for on first "post-war" markets.



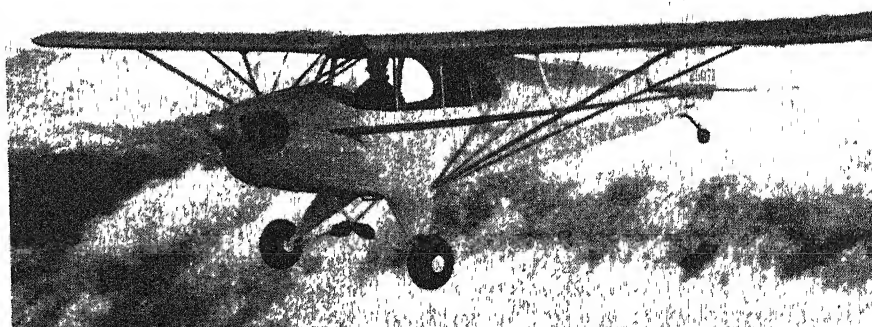
Cessna (left) is aerodynamically conventional, features metal construction and unusual type landing gear. Piper Cub (below) is refined version of the reliable pre-war models

the answers to these questions. Plane manufacturers want to know what the public seeks in a plane, how many can be sold, and at what prices. Sales-and-service agencies must determine marketing areas and plan their scopes of operation. The government must be able to apply judicious regulation to private flying, aviation personnel, air-traffic, and airports. And industry—probably the largest immediate user of private planes—must examine the advantages of company-plane ownership, and relate them to the commercial scene.

One question seems to be fairly well answered. The immediate prospects for private flying are most

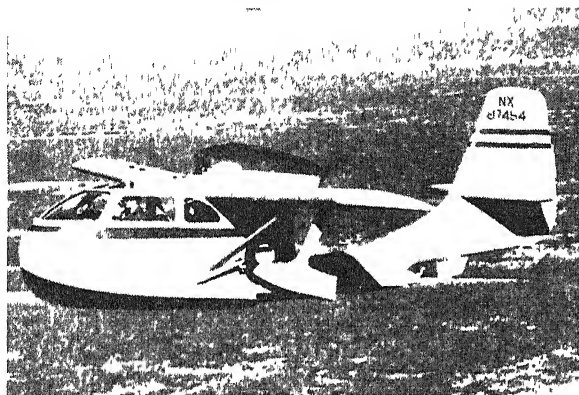
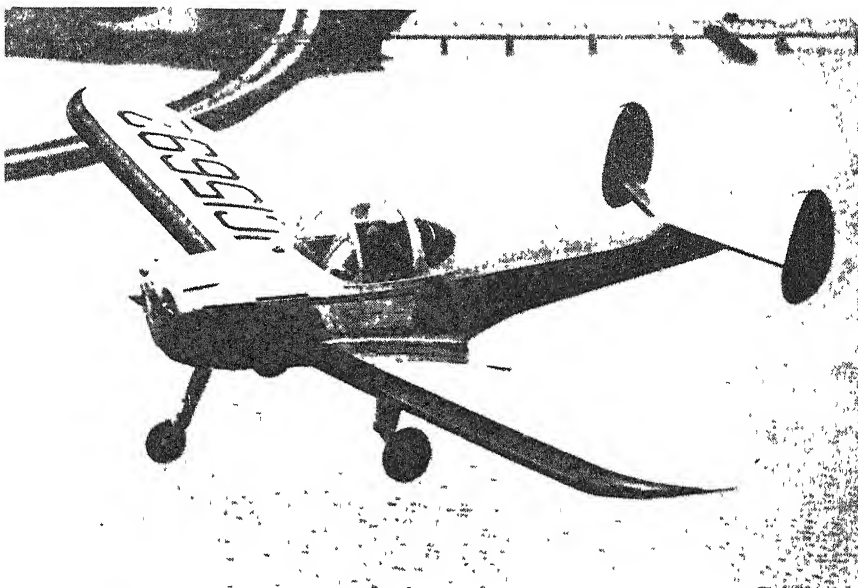
search Corporation, builders of the Ercoupe, for example, have a backlog of over 11,000 orders for 1946

There is a tremendous demand from ex-service men for moderately priced airplanes. Manufacturers, however happy they are because of this demand, do not believe it will last. When these young men have settled down to civilian occupations, they are most likely to sell their



planes than to buy new ones. Young men and women who did not fly in the war, and members of flying clubs, may take their place. More mature purchasers of personal planes, with incomes of over \$10,000 a year, will probably provide a moderate market for the four-seater. But, because industrial utility can best overcome high costs, commercial aircraft builders look to industry and business, and to some extent to agriculture, for the most valuable market during the next few years.

IN INDUSTRY — Many companies have already recognized the advantages of having their own planes. Executives can save time, arrive fresh at their destinations, supervise plants more intimately, iron out



In stall and spin-proof class, Ercoupe (above) is easily flown. Republic "Seabee," at left, features utility of amphibian design

difficulties in closing contracts, and so on. Salesmen can cover more territory, and emergency parts can be supplied with greater rapidity by company aircraft. Some pharmaceutical companies have found private planes valuable for delivering drugs and other aids quickly to the scene of a disaster. As a typical example of private industrial plane operation, Socony-Vacuum has a whole fleet of airplanes for its pilot-salesmen, and considers it as incongruous for an aviation salesman to travel in anything except an airplane as it would be for an automobile salesman to go about in a horse and buggy. The Socony fleet includes Beechcrafts, Fairchild's, Cessnas, and Stinsons, 2 to 14 place, with power plants ranging from a single engine of 65 horsepower up to two engines of 1200 horsepower each. Each plane is equipped with two-way radio and blind-flying instruments. For convenience, these planes are based at various fields throughout the country.

DESIGN—For the present, light-aircraft design is still marked by many honest differences of opinion on basic features. Some manufacturers like high-wing monoplanes, some like them low, but the once-

vigorous controversy about wing position has quieted somewhat. Two other controversies are now in full swing. One is the tricycle landing gear, with a nose wheel at the front of the fuselage, versus the conventional landing gear. Here, opinion seems to favor the tricycle gear with which a pilot can safely make cross-wind landings.

With respect to control systems, the second point of dispute, there are two well-defined camps. Many experienced pilots prefer three independent controls—rudder, ailerons, elevators. They want a maximum of maneuverability, and independence of action with enough "up elevator" to stall and spin the airplane if desired.

For the younger school of pilots, stall-spinning is a useless anachronism. The preference here is simplified controls that limit the upward travel of the elevator so that the plane cannot be stalled. In addition, either the rudder and aileron are coordinated, or else the rudder is eliminated altogether. In either case, the foot pedals are removed and the skill required in coordinating ailerons and rudder is no longer required. Although these limitations rule out extreme acrobatics, the proponents of simplified controls

feel that stunting has no value in ordinary flying. The inherent safety of simplified-control systems is indicated by the Civil Aeronautics Administration ruling which permits a student to solo after only five hours on a spin-proof, two-control airplane.

PLANES TODAY — The \$700 air flivver, predicted a number of years ago, is not here yet. But, for those who are considering the purchase of an airplane, there is a fairly good range of selection. At the \$2000 end of the scale, the reliable, well-designed two-seaters, such as the Piper Cub with a 65-horsepower Continental engine, offer cruising speeds of about 75 miles per hour, ranges in the neighborhood of 200 miles, 50-pound baggage capacities, and 12 gallon fuel tanks. The stall- and spin-proof Ercoupe, also a two-seater but faster and more expensive, is powered with a 75-horsepower Continental, and is priced at \$3050. It cruises at 110 miles per hour, has a range of 500 miles, and carries 65 pounds of baggage and 23 gallons of fuel.

Further up the price scale, the four-seater category includes the \$5000 Stinson Voyager (150 horsepower, cruising speed of 125 miles per hour, and 40 gallons of fuel), the \$5375 Bellanca Cruisair with the same power but a higher speed of 145 miles an hour, and the more luxurious Fairchild F-24 with a 175-horsepower Ranger in-line engine at a price of \$8875.

In the twin-engine executive-plane class, the Beechcraft D18S—six to eight seats, two 450-horsepower Wasp Juniors, single engine safety, a cruising speed of 200 miles per hour and a range of 900 miles—is offered for \$59,500. Moreover, there are some excellent single-

engine and twin-engine amphibians available. Unfortunately, there are many reasons why it is still impossible to buy a four-place airplane for \$1000; these reasons include moderate production volume plus high cost of engines, accessories, and equipment. But manufacturers state that present prices are considered reasonable by purchasers and that, as production goes up, delivery prices will go down

FINANCING — Following directly from the present high cost of personal airplanes is the practical question of purchasing airplanes "on time." Many of the banks and installment companies which finance automobile purchases are equally interested in financing aircraft. The actual terms of sale are generally one third down and the balance in 12 months, while the usual bank interest rate is 5 to 6 percent

Aircraft financing is similar to automobile financing, but it has some peculiarities. For one thing, all matters of transfer of title and recording of liens are handled by the Civil Aeronautics Administration in Washington. The credit statement is similar to the one used in buying furniture, but it has to be accompanied by an "Application for Hull Insurance." It is worthwhile to note that under the "Participating Lightplane Policy," the plane owner takes 25 percent of any loss while the company takes 75 percent. Such participation is an added incentive for the pilot-owner to be careful.

Buying on time means insurance, and it cannot be said that aircraft insurance is cheap. Cost varies with conditions, types of policy, and so on. The purchaser may have to pay between 10 to 15 percent of the cost of the plane annually. Companies specializing in aircraft insurance are now engaged in a safety campaign, with a view to subsequently reducing the rates.

Regarding the over-all cost of private plane operation, Mr. John H. Geisse of the CAA recently reported: "In the pre-war period, it cost just about \$1000 a year to operate a small, \$2000-airplane for 100 hours. The cost per mile was just under 13 cents for this usage. A major factor in these costs was the cost of insurance. The substitution of automobile insurance rates would drop the cost to \$600 per year, and less than eight cents per mile. Because of the high insurance rates and the hangar charges, the annual overhead is high and hence the costs per hour are affected materially by annual usage. Increasing the annual usage from 100 to 200

hours per year in the case given, with pre-war insurance rates, reduces the cost per hour from ten dollars to six dollars and at 1000 hours per year, the cost drops to about \$275 per hour or about 3½ cents per mile"

PLANES TO COME—After the first post-war efforts to get conventional or semi-conventional private planes onto the market have leveled out, it may be expected that more radical designs will make their bid for public acceptance. Some of the more interesting of these "dream" planes include several roadable models in which the wings either fold or are removed at the airport, so that the plane may pinch-hit as a reasonably satisfactory automobile. Actually, it is extremely difficult to combine the best characteristics of an automobile with those of an airplane. Inevitably, the hybrid loses some efficiency on both sides, but roadable planes have been flown and many authorities maintain that private flying will come into its own only when the automobile-airplane has been perfected.

Aiming at substantial improvements in vision and comfort, minus the usual propeller noise, many manufacturers are investigating pusher-propeller designs. Some would mount the propeller at the extreme after-end of the fuselage and use gearing and shafting to

couple engine and propeller together. This has been done successfully on larger planes such as the high-speed Douglas "Mixmasters."

Other suggested power and propulsion ideas would provide jet-driven propeller blades with the exhaust gases exiting at the blade tip. Here it is claimed that a rudimentary combustion chamber at the propeller hub would be all that is necessary for a simple, cheap, and light power plant. As with most jets, fuel consumption would be high but it is felt that economic and other advantages would outweigh this.

Not content with three or even two-control systems, engineers at Consolidated-Vultee are experimenting with the Spratt wing which is mounted on a universal joint above the fuselage. One control—the stick—moves the entire wing in a manner that accomplishes the combined functions of rudder, elevator, and ailerons.

A considerable portion of the doubt regarding private aviation centers about the question of safety. Again referring to statements of Mr. Geisse of the CAA, it is reported that accident figures for stall- and spin-proof planes now stand at 4,000,000 miles flown per fatal accident. Using 5000 miles per year as about the maximum that a private pilot can be expected to fly, it would take one pilot a reassuring 800 years to accumulate this mileage!

* * *

METAL-BALSA SANDWICH

Combines Lightness, Strength, and Formability

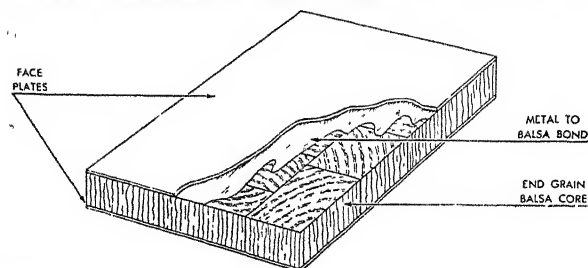
CONSISTING of thin sheets of high-strength aluminum alloy, separated by a thick, low-density core of balsa wood, Metalite, a new structural material, is described as forming a light, rigid unit. The grain direction of the balsa core is set at right angles to the much thinner metal faces. Bonding of core and faces is done in one operation, under moderate heat and pressure, in a mold of the desired shape.

Because of the thickness gained by the light core, the bending stiff-

ness of a completed panel is many times greater than that of the single sheet of metal of the same weight according to the makers, Chance Vought Aircraft. The panels also provide great resistance to failure either by local wrinkling or under transverse-shear loading.

Metalite, it is reported, eliminates skin wrinkling of aircraft surfaces under load, and because whole panels can be fabricated with scarcely an external break, parasite drag may be reduced to a minimum. It is anticipated that designers of ground transport and, perhaps, domestic equipment will also find the material useful.

Thickness and rigidity, without a proportionate increase in weight, are added to metal by light balsa core



Factories On The Move

• LOOKING AHEAD •

Scientific management planning grew slowly at first; blossomed fully under the pressure of war. . . Now, the same type of thinking that boosted production is being used to integrate processes and products with the economic warp and woof of the market area beyond plant walls. . . Modern industrial planners have far greater freedom from technical bugaboos than did the tycoons of yesterday; however, subtle under-surface factors must be recognized and evaluated.

IF PLANS which hundreds of industrial managements laid down during the war are carried out, then industrial plants soon will be on the move as never before. Eastern managements plan to move west, westerners east, northerners south, southerners north, big-city plants to small towns, rural plants to big towns, mid-city shops to the suburbs, and suburban ones to the center of town.

Large companies and small ones alike are involved. General Electric Company long since announced a program to move production units out of its huge Schenectady works and scatter them among small towns at least 100 miles away. A power-transmission equipment maker and a precision-castings producer have both pulled up stakes in small towns, moved to where their plant windows almost are illuminated by the bright lights of Times Square.

Opposite to all this, big companies like E. C. Atkins Company emulate the suburbanite who wrote an advertisement to sell his house, read back his own copy, and decided that if the place was that good he had better keep it. They add up all the factors on both sides of the moving-or-staying question, and decide to stay. But in staying, they still will make changes. They will modernize buildings, readjust shipping facilities and methods, try

With Forethought and Planning that Rival the Best-Laid Strategies of Armies, Industry is Shifting to New Sites. Local Skills, Water Power, Climate, and Other Once-Vital Factors Yield to Emphasis on Markets, Tailored Transportation, and Community Outlook

By EDWIN LAIRD CADY

to obtain where they are everything that they could get by moving.

Behind the trend toward re-locating plant facilities is the solid fact that the points by which industrial locations are judged are changing

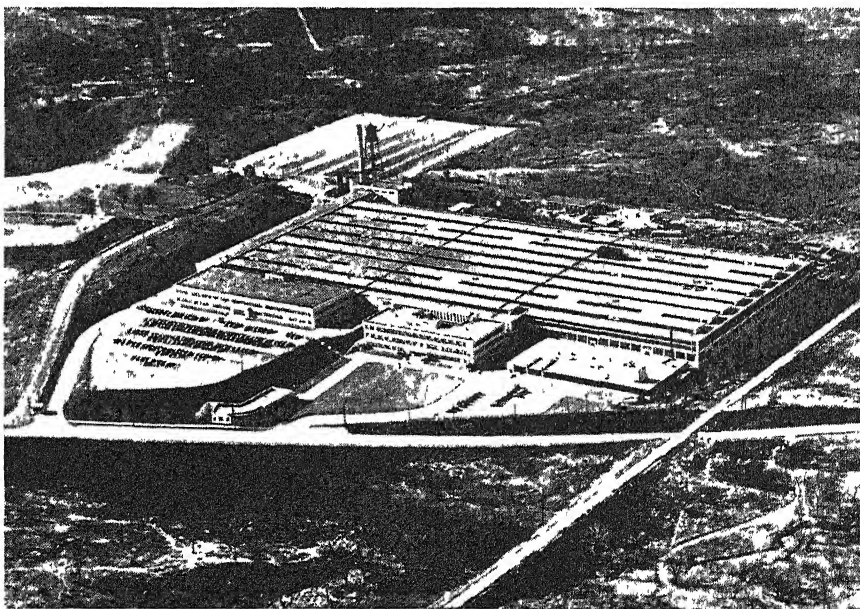
LOCATION TECHNOLOGY — Climate is an example. Plants once located where the climate was hot for vat impregnating of wood products, cold for foods storage, moist for cotton spinning, dry for air-drying of chemicals, and so on. But now, factories are so easily re-climatized—specially air conditioned—and their air conditions are kept so sensitively adjusted to the needs of processes, that it makes much less difference what the weather on the outside may be.

Water is a similar case. From soda pop to fine chinaware, there used to be thousands of products which were good or bad in accord-

ance with the chemical conditions of the water supplies where they were made. But now, all "critical" water is specially conditioned no matter where it comes from.

Labor factors also have changed. Industry has learned that so-called "cheap" labor can be highly expensive. Anyway, national laws and nation-wide labor unions are seeing to it that this consideration is no longer very important. And the speed with which almost anyone can be trained to work in a modern plant was so well demonstrated during the war that the concentration of specialized craftsmen in localized areas no longer means as much as it used to.

MARKET STUDIES—Now, markets for finished products are taking over as the number one consideration in plant locating. This factor is not new, of course, but the scientific



Located "downtown" for years, Emerson Electric has moved to the outskirt location and modern plant shown here. Space for cafeterias, employee recreation, and new medical facilities are important supplements to expanded manufacturing activity

thoroughness with which markets are studied today is not more than 15 years old.

These market studies are co-operative affairs. A maker of chlorine products for household and factory disinfection is making such a study right now. Wholesale grocers and other distributors are helping with it; they are telling just how the transportation costs and speeds from various locations would influence them when considering the purchase of these products. Railroads are telling what they can offer in spur-track facilities and in land rentals. Builders of special automobile trucks and bodies are looking at the delivery problems, offering tentative plans for the fleets that would be needed for short distance delivery from loading platform to city points, or for longer distances. Communities are deciding whether they want the plant or not, what buildings and land locations they have, what they will offer in tax concessions and in financial help.

Every one of these studies is based upon the factors of how much disinfectant can be sold, to what consumers, at what distances from the plant, and at what distribution costs. Competition is considered too. There is no point in putting the plant in a community which already is so well served that only cut-throat methods will get the business. Rather, a series of plants will be lo-

cated in communities that need the product.

Studies like this one are being made everywhere. And what a community learns from studying the problems of a chemicals company, it can apply when extending invitations to other industries. As a result, communities know themselves and their industrial needs as never before.

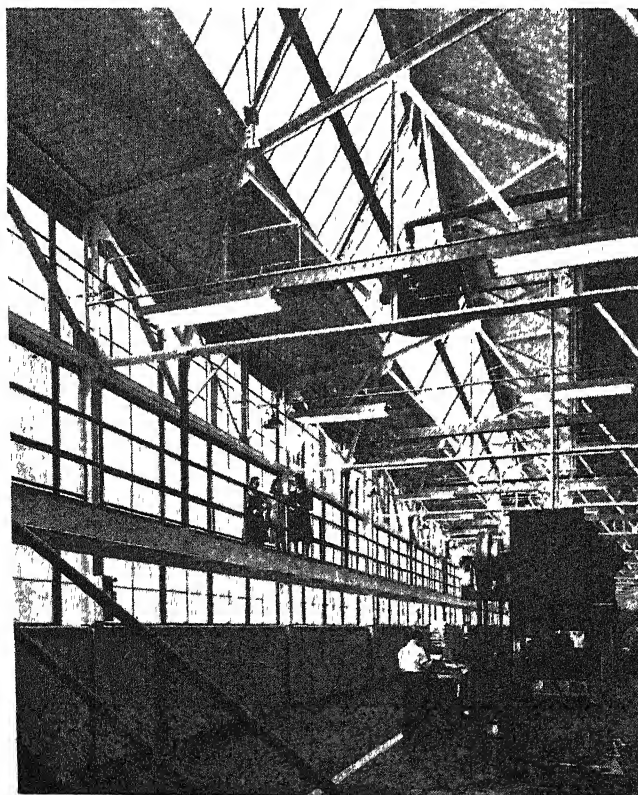
The city of Cleveland has an extensive advertising campaign to attract "end-product" industries to its district. Many years ago, it began to build up as a center for the production of steel, aluminum, and other materials. Now, it wants to fabricate more of these into consumer products, cut down on freight costs to fabricators' plants, and let its metals-melting plants get more of their scrap materials from their own back yards. Numerous other communities are following the same idea. They know what industries they need to support and augment their present ones, and they are as discriminating as they are aggressive in going after them. But back of every such campaign is a series of scientific studies of markets and distribution costs for the goods to be made.

TRANSPORT — The transportation picture is changing. The change is not as rapid or as thorough-going as it might be, of course. Commodity classifications for freight still exist,

excepting for air freight, and they still will be hampering the economics of plant locations and of marketing as long as carriers and politicians can make capital of them. But cutting steadily into the tendency of the commodity-classification rate to confine some industries to some localities is the specially designed freight car, ship, truck body, and even airplane.

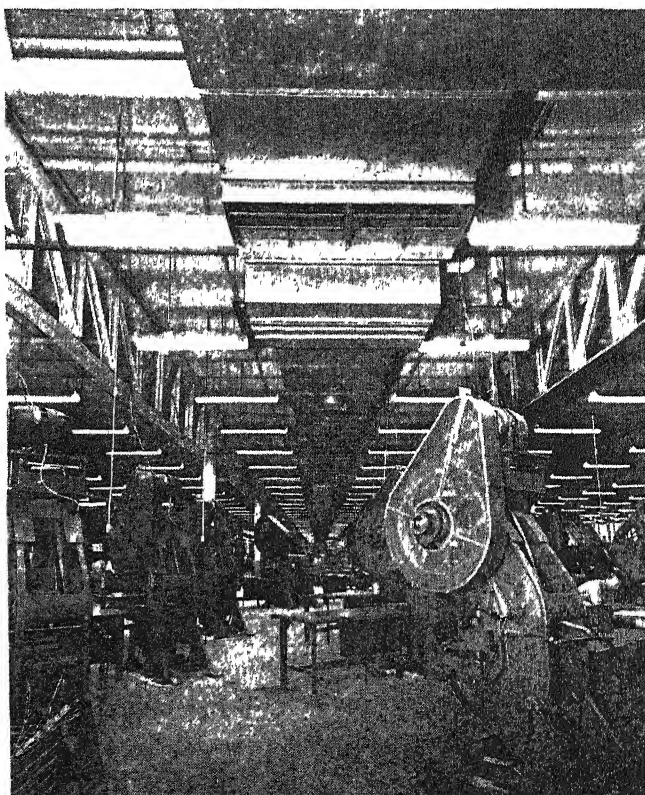
These specially designed vehicles turn common carriers into materials-handling devices. They make overland transportation part of the production line.

Everyone has seen the motor trucks that mix concrete as they transport it, the refrigerated freight cars for perishable foods, and is familiar with the lake ore freighters which are materials-handling plants on hulls. Not so familiar are the special cars and trucks designed to ripen fruit en route from farm to city, and to permit air-drying or even chemical processing of materials while in transit. But the engineering theory of "processing while in transit"—of using specially air-conditioned cars to give paper the right moisture content while en route to the printer rather than forcing the printer to store the paper in a special room while the air conditions it, for example—is finding wide applications and will find still wider ones when some of the present transportation unit designs get into production and extensive use.



Courtesy Albert Kahn Associated Architects and Engineers, Inc.

Unobstructed light and clean air make large window areas (left)



Boeing Airplane Company Photo

practical. Air conditioning—note overhead ducts—and high-level artificial lighting installations (right) allow the selection of plant locations to be predicated on market rather than climatic factors

Combining with all this is the dependability of modern production equipment. Factories do not have to keep their machines in factory towns where maintenance supplies are to be had quickly. They can take them almost anywhere and depend upon trouble-free operation.

RAILROADS HELP—Plywood companies are taking their veneer-sheet-cutting operations out into the woods, avoiding the costs of shipping whole logs into their highly integrated central factories. This procedure is made possible first by the dependabilities of the processing machines which operate in the forest plants, and second by highly intelligent action on the part of the railroads. The railroads allow a "milling in transit" rate by which the mills pay only one freight cost—that from the woods to the consumers—and ignore the fact that the sheets stop en route to go through the central plants for gluing and for special processing.

Another excellent business operation by the railroads is the building of special industrial districts. These districts are zoned as carefully as any residential district. Part of the zoning is to make sure that the factories in question will have good markets locally and along the right-of-way served by the road. Another part is to make sure that each plant has enough land and space, properly laid out for efficient manufacturing, plus a little extra in which to grow, but not enough extra to hold industrial land out of use. The railroad then runs service tracks to the points where spur tracks must begin, thus saving the plants the cost of running long spurs at costs averaging from \$5.00 to \$8.50 per foot. As operated by the M-K-T and other forward-looking lines, this method leads to well-balanced industrial communities worked out on thoroughly scientific business management bases.

WHY PLANTS MOVE — There are many reasons for moving plants. One company found that its district had insufficient water supplies for adequate fire prevention, moved to a location on heavier mains. A small manufacturer of transformers located "in the back yard" of a copper-products jobber, has instant access to highly varied raw materials. A company which makes extensive use of electricity for welding, brazing, and induction heating got so much practical advice from an engineer of the Commonwealth Edison Company that it moved closer to his office so it could consult him more often.

Scrap disposal is a problem. The difference between profit and loss on the disposal of kraft and other paper scrap often lies in the distance from a consuming market. Companies which have large supplies of unsaleable scrap often move to waste land on the outskirts of large cities. One such company bought a badly eroded farm, used its waste to fill and block up the gullies, added good top soil and then sold the land for residential properties. Many swamps have been filled in with industrial waste and then sold at good-land prices. A wise management can make quite a large secondary profit in this way, and if it is filling up gullies or otherwise moving its waste down hill, can at the same time minimize the handling costs of its scrap.

The problem of whether a plant should move or not often becomes most acute when it has increased the value of its land and built up a community about itself. If it moves without finding other employment for its workers who live nearby, then it drags down the values it has built and must take several years to build equivalent ones in a new location. If it does not move it may suffer the penalties of heavy

traffic congestion in a built-up community, and of obsolete buildings and machines.

Many a plant is moving for no other purpose than to break old habits. The management may need new machines but be unable to get financial backers to dispose of the old ones unless it moves a long distance and does not take them along. When a building scientifically designed to be a tool of production is needed, it may be cheaper to start with a bare field than to tear down present buildings and rebuild.

In case after case, there seem to be more reasons for moving, or for establishing branch plants, than for not moving. The long-term part of the reconversion job will find plenty of industries on the move. But the re-locations of today are quite different from the opportunistic ones of a few years back. The "grab any plant on any terms" spirit of the old chamber of commerce is gone. Modern moves are made on the basis of cold scientific planning, with railroads, power companies, and communities as well as plant managements helping with the planning, and with little encouragement for the plant which does not look before it leaps.



INDUSTRIAL DIAPHRAGMS

Take Advantage of Properties Of Synthetic Rubber

THE DIAPHRAGM as used in mechanical engineering consists generally of a disk or other shaped piece of flat and non-rigid material held firmly at its periphery but with its middle portion free to move as far as the elasticity of the material permits.

Diaphragms of leather, of extremely thin metal sheets, and of rubber and fabric laminates, are an old story as pump parts and as the activating members of air speed gages. But coming rapidly into the industrial field are diaphragms made of the new synthetic rubbers and their laminates.

One such application is an oil shield for anti-friction bearings. Used as the end cap of a closed-end housing, the material will expand with a slight diaphragm action when the oil in the bearing is running hot from high bearing speed, but will contract to restore full oil volume to the races and retainers when the bearing speed and temperature are reduced. Thus the diaphragmic action provides an automatic pressure-relieving reservoir for heated oil and prevents the lubricant from

being forced past the seal at the shaft end of the bearing.

Other new uses are in highly sensitive proportioning gages for hot or cold gases. Here the extreme uniformity of the synthetic rubber allows close and dependable control, while the resistance to heat, dryness, and corrosive fumes provides long life.

DESTRUCTIVE VIBRATION

Absorbed at Source by Metal's Grain

VIBRATIONS are inescapable because any running friction in a bearing and any dynamic unbalance in a part may cause them. They are damaging because they force loads and speeds to be kept down and they set up fatigue factors that are destructive to metals. Where they cannot be reduced below the damage points by eliminating their causes, they must be dampened. A method whose use is growing rapidly is to make the vibration producing parts out of metals having such grain characteristics, or out of forgings having such directional strengths, that the vibrations are caused to do work within the metal itself and thus are dampened at their sources.

Chemical Crop Insurance

TODAY, world-wide food shortages emphasize all too grimly the importance of agriculture. Farming is not the haphazard process it once was. Although crops are still subject to all the vagaries of the weather, some of the other dangers—diseases, pests, and weeds—are being reduced by the contributions of chemical research. These dangers can be controlled or eradicated, and crops can be improved. As with other business, however, investments in time, money, and experiment are necessary, and farmers must spend millions on fertilizers, insecticides, fungicides, and other chemical aids. But the money will be returned, with interest, in the form of more and better foods for a hungry world, if the correct investments are made.

INSECTICIDES—Only within the past few months, several promising insecticides have been introduced to the market. Some of these are chemical relatives of DDT. One has just one chlorine atom less than DDT and is called DDD. Said to be equal to DDT in most respects,

and superior in some, DDD is cheaper to manufacture than DDT. A commercial formulation of it is now undergoing tests and will soon be introduced to the market.

A fluorne analog of DDT, called Gix, was manufactured in Germany during the war. Gix was claimed to be more effective than DDT, but it is much more expensive to make. Less effective than DDT, but considerably cheaper to make, was Lucex, made by chlorinating the side chain of ethyl chlorobenzene.

The English, meanwhile, developed a different type of insecticidal material by adding chlorine to benzene under the influence of sunlight. Potent against insects, this compound, called 666—benzene

Like the Weather—Insects, Rodents, Weeds, and Other Crop Criminals have Long had Little Done About Them. Now, Spurred by War and Famine, Chemistry Turns Tongue-Twisting Terms into Literally "Down-To-Earth" Products that Protect Plants Against Nature's Scalawags

By HOWARD C. E. JOHNSON, Ph.D.

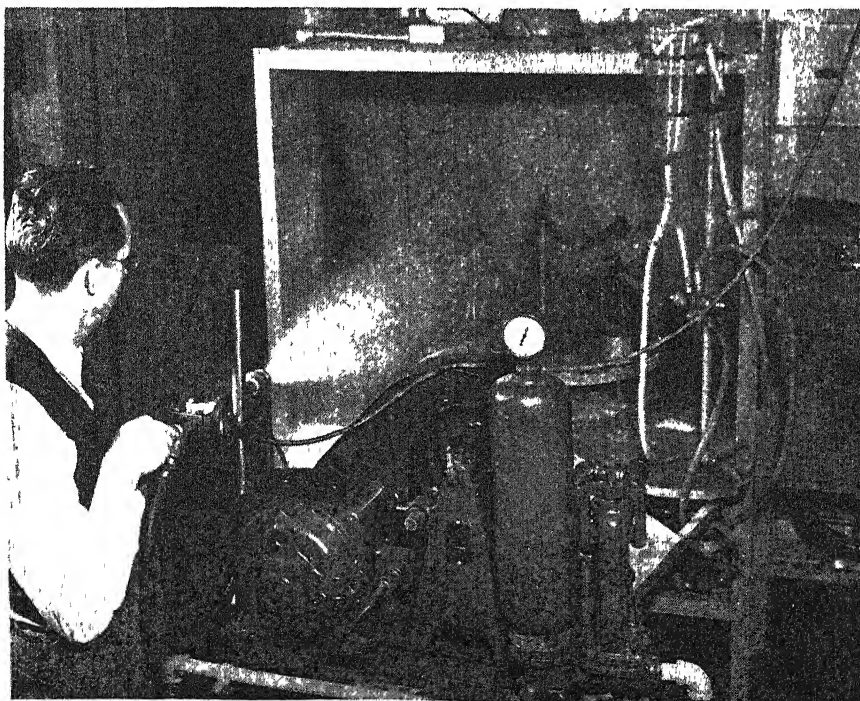
Chemical Editor, Chemical Industries

• LOOKING AHEAD •

Fewer "bad" years as farmers adopt chemical means of crop protection now becoming available. . . More food, in spite of dwindling farm labor supplies, because losses are lower. . . Fruit held on the trees until markets and shipping space are ready. . . Surer planting with chemical germination tests. . . Substantial reductions in rodent populations are a result of new poisons.

hexachloride—exists in four different forms, or isomers, which differ only in the geometrical configuration of the atoms. One of these isomers, the so-called gamma isomer, which occurs to the extent of 10 to 13 percent in the mixture, was found to possess the greatest insecticidal activity. The concentrated material is known as Gammexane. Reports indicate that 666 may find use as an aphicide and in the control of cotton insects. It is also toxic to the African migratory locust, house cricket, German cockroach, oriental cockroach, body louse, bed bug, cabbage caterpillars, winter-moth caterpillars, clothes-moth caterpillars, various flea beetles, mustard beetle, blossom beetle, apple-blossom weevil, pea and bean weevil, grain weevil, hide beetle, wasps, ants, various mosquitoes, houseflies, various fleas, poultry red mite, sheep tick, and woodlice.

Gammexane, or 666, may be applied as a dusting powder with gypsum as a diluent; dissolved in an organic solvent and diluted with kerosene for spraying; emulsified



Testing spray rig—proper application is important for most insecticides

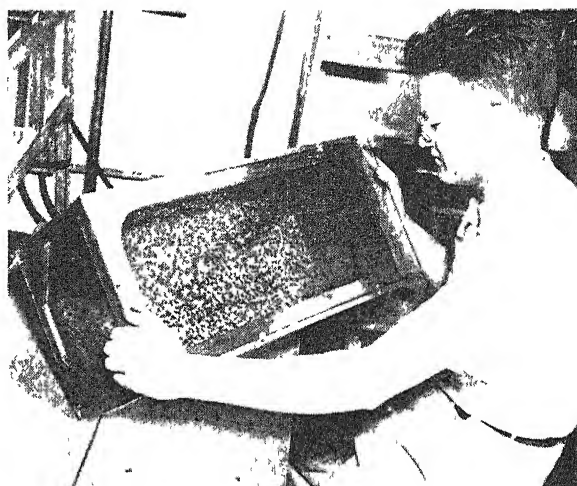
in water, or volatilized from a hot plate to give a smoke. Although 666 is very stable to heat, it breaks down in the presence of alkalies to give hydrogen chloride and trichlorobenzene. It cannot, therefore, be mixed with lime, or other basic compounds for dusting.

This insecticide is now being tested intensively in the United States.

Although the foregoing compounds have received the most attention, several other new insecticidal materials have been studied. The hexaethyl ester of tetraphosphoric acid is claimed by the Germans to be an excellent substitute for nicotine for use against aphids. In the United States, a chlorinated hydrocarbon called 1068 has been introduced to the market. Like 666, it is also recommended for control of aphids and cotton insects. In addition to encouraging the search for new materials, experience with DDT also led to improvements in methods of application. The "aerosol" method, where the material is dissolved in a liquified gas such as Freon, has been found to be as effective in the field as in tents and buildings. The active ingredient is dispersed in a very fine state of sub-division by volatilization of the gas, giving excellent coverage and speed of kill. In some cases, however, long-lasting activity is lost.

FUNGICIDES — Although dithiocarbamates and the closely related thiurams were developed and patented several years ago as fungicides, they have only recently come into general use. Fermate and Zerlate, iron and zinc compounds of the first material, are both coming into wide use to treat various plant fungus diseases. Oxidation of the dithiocarbamates gives the thiurams

Flies, reared to full health and vigor in Pest Control Laboratory, are used to evaluate knock-down and killing power of experimental insecticides under standardized conditions



Courtesy Du Pont Company

which are used as turf and seed fungicides.

Isoquinoline lauryl bromide, made under the name of Isothan Q15, has been studied as a fungicide for apple scab. And heptadecyl glyoxalidine, known also as compound #341, has shown effectiveness against apple, cherry, and rose diseases. The Germans developed a material for treatment of oat and rye seeds which appears to be completely effective when the seeds are soaked for 30 minutes in a 0.1 percent water solution of the compound.

PLANT HORMONES—A few years ago, it was found that apple and pear dropping in the fall could be retarded by spraying with synthetic growth regulators. About the same time, it was discovered that these substances would also promote the growth of roots.

Affecting the life cycle of a plant much as hormones affect the cycle of the human organism, the synthetic regulators were called plant hormones. Recently, they have been found useful for fruit setting, blos-

som thinning, fruit ripening, delayed budding, early flowering, prolonging dormancy, delaying abscission, grafting, producing wider angles between the trunk and branches of fruit trees, inducing seedless fruit, and selective weed killing.

The compounds found most effective were the aryloxy acetic acids. One of these, 2,4-dichlorophenoxyacetic acid, known commonly as 2,4-D, has attracted considerable interest as a selective weed killer. Generally speaking, 2,4-D kills broad-leaved plants and is harmless to grasses when applied at the rate of 200 to 300 gallons of a 0.1 percent solution per acre. Dusts and aerosols have also been tried, but they are more difficult to control and wasteful of material. Although the sodium salt of 2,4-D is soluble in water, the commonest commercial material is the acid itself, formulated with a carrier or emulsifying agent.

The chemical kills most field, pasture, and lawn weeds without harming lawn grasses or cereal grasses such as corn, wheat, oats, rice, or barley. As shown in the accompanying table, many other weeds are also killed and continuing studies are broadening the usefulness of the new herbicide. Commercially, 2,4-D is available in three different types of formulations: the acid itself, which must be dispersed in water; water-soluble salts, either sodium or triethanolamine; and esters, such as methyl or butyl, which must also be dispersed.

The mechanism of selective weed killing is still being studied. It was thought at first to be a hormone action, causing the plant to "grow itself to death," but many excellent plant hormones do not behave similarly. Apparently, the herbicide attacks the chlorophyll of the plant in some way not yet clear. Acting as a "systemic" poison, it kills not only the tops but the roots as well.

Other uses besides that of a herbicide are being discovered for 2,4-D:

Weeds Killed by 2,4-D Chemical Plant Hormone

Field and Pasture Weeds

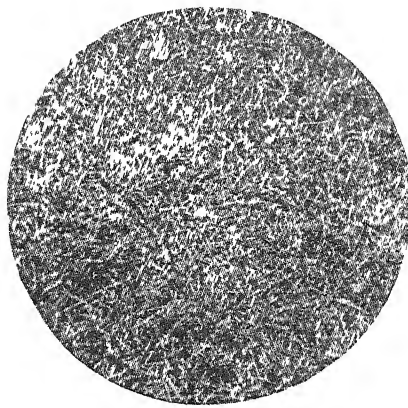
Poison Ivy	Bull Thistle and other Thistles	Wild Mustard and other Mustards
Poison Oak	Chickweed	Burdock
Bindweed	Poverty Weed	Fleabane
Morning Glory	Nut Grass	Ragweed
Honeysuckle	White Top	Water Hyacinth
Sumac	Russian Knapweed	Pigweed
Sassafras	Spreading Dogbane	Klamath Weed
Black Locust	Bitterweed	Primrose
Choke Cherry	Blueseed	Dog Fennel
Cocklebur		

Lawn Weeds

Dandelion	Heal-all	Ground Ivy
Plantain	Knotweed	Purslane
White Clover	Chickweed	Oxalis
Pennywort	Hawk Weed	Wild Garlic
Wild Carrot	Speedwell	



After treatment with 2,4-D in a 0.1-percent mix, weed-choked lawn (above) is entirely clean (right). Hormone is effective on many broad-leaf weeds



It was recently reported, for example, that the methyl ester keeps stored potatoes from sprouting

The English have also developed a similar material differing from 2,4-D only in that one of the chlorine atoms is replaced by a methoxy group. It is sold under the name "Methoxone."

Another compound which is useful as a blossom thinning agent as well as an insecticide and fungicide is the sodium salt of dinitro-orthocresol, formulated and sold as "Krenite." It has been used to thin apple and peach blossoms, and, moreover, is recommended for the control of various aphids, budmoth, peach-leaf curl, raspberry blight, sooty blotches on pears, and apple scab. Except in a few special cases, the material is applied as an insecticide and fungicide to dormant plants—before any appreciable amount of green tissue shows. To control apple scab, Krenite is sprayed on the orchard floor in the spring to kill the mold spores wintering in the dead leaves.

Still another German development with valuable implications is the use of triphenyl tetrazolium chloride as a reagent for testing the fertility of seeds. The compound is used as a 1 to 2 percent water solution. Cereal seeds—wheat, oats, corn, rye, barley, and so on—are soaked in the solution for six to eight hours except in the case of oats, which require 24 hours. The germ cells of the seeds that will germinate turn red. Seeds thus tested are not harmed, for the material is non-toxic.

RODENTICIDES—Insects and molds are not the only villains who prey upon the farmers' crops. Rats, for example, cause \$500,000,000 damage a year, mostly on farms.

A new rodenticide, known as "1080," has been developed by the United States Fish and Wildlife

Service. Chemically, it is sodium fluoroacetate. Extremely poisonous, and without identifying odor or taste, it is extremely hazardous in the hands of anyone except an expert. But "1080" is as deceptively innocent to rats as it is to man, and the animals do not disdain food that has been treated with it. It will be made available, however, only through experienced pest-control establishments.

Indications are that the compound will also be helpful in keep-

ing down the population of unwanted mammals in the western states. With gophers as a target, poisoned grain can be scattered effectively in such small quantities that grazing cattle or sheep will not be harmed. Or the poison can be introduced into the bloodstream of an animal, whereupon the carcass becomes lethal to coyotes.

Alphanaphthyl thiourea, commonly called ANTU for short, is a chemical which kills rats upon contact.

A war-developed German rodenticide called "Castrix," is claimed to be one fourth as toxic to rats as strychnine. Castrix, however, is non-toxic to chickens and other fowl at the concentration used. When grain is impregnated with a 0.1 percent water solution and used as bait, it is effective against mice and to a lesser degree against rats.

Thus, the war against the destroyers of food goes on, and although the problems are far from solved, chemistry is providing an ever-growing arsenal of efficient weapons

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ANTI-ROACH FLOORS

Eases Roach Problem in Food Handling Areas

FINELY divided metallic copper incorporated in magnesium oxychloride cement, familiar in flooring compositions, has lately found a new and important value. Floors of this composition, long known to suppress the growth of fungi, particularly that of athlete's foot, now have been shown to be offensive to cockroaches. Tests indicate that roaches scrupulously avoid floors of this composition and will not cross them to reach food. Apparently the composition is disagreeable to the insects only on contact.

MAN-MADE TAN

Alleviates Loss of Chestnut Extract

CHESTNUT trees, the chief source of sole-leather tanning agents, appear doomed to extinction by blight in this country. However, efforts by Monsanto Chemical Company chemists to evolve a synthetic tan are now said to have resulted in a product superior in some ways to the natural product.

It is of interest that a large proportion of the sole leather tanneries in this country are located in Pennsylvania because the chestnut grew abundantly in that region. The ground logs and bark are "brewed," like tea, with hot water and the in-

fusion concentrated to obtain the tannins. Now, most of the trees are killed off, but natural tannins are still being made from the dead trees.

The new product, called Exan, is said to impart to sole leather a fine, smooth grain as well as tightness, firmness, pliability, and excellent water-, wear-, and abrasion-resistance.

LOST SPRAY-PAINT

Recovered and Re-Used with Emulsifier and Solvents

ONE THIRD or more of the paint and lacquer that leaves the spray gun is normally lost in spray-booth applications. But a major portion of this loss may now be recovered by a war-developed process, said to yield reclaimed coatings which are the equal of new paints and lacquers.

Paint normally caught in the curtain of falling water that protects the spray-booth walls is precipitated in the form of a water-and-paint (or lacquer) sludge. The free water is separated from the sludge, and the solvent which has been lost by evaporation is replaced by a mixture of an emulsifying agent—sulfonated castor oil or the like—and an organic solvent or mixture of solvents, such as acetone, xylene, butanol, butyl acetate, or naphthas. The mixture is then agitated, resulting in a water-in-oil emulsified coating which is ready for re-use. The process is controlled by the Meckler Chemical Corporation.

Molding Unlimited

Known by Various Names, Impression Molding Removes Many of the Barriers that Have Stood in the Way of Producing Plastics Products in Large Sizes. It Also Eliminates the Need for Expensive Molds and Heavy Machinery. Production Processes Can Be Fast and Continuous

By CHARLES A. BRESKIN

Editor, *Modern Plastics*

OF ALL the plastics developments that either started or received their greatest impetus during the war years, impression molding perhaps holds the greatest promise and, at the same time, is subject to the greatest controversy within the industry. Since even the name has come in for its share of discussion, it might be well to start off this probe into the most promising fields for its application with a description of just what the term "impression molding" embraces.

All of those plastics processes—variously known as flexible-pressure molding, fluid-pressure molding, contact-pressure and low-pressure laminating—that use materials for which pressure requirements are very much lower than in conventional production methods, come within the scope of impression molding. Since the pressure necessary to hold in the volatiles and to position the material during processing is eliminated in the impression-molding method, the only pressure requirements are that the materials be held in firm contact with each other and with the mold,

and that the desired surface finish be produced.

The effect of this marked reduction in pressures is to make possible the production of many types of plastics parts that are either impossible or impractical using conventional high-pressure methods. With high pressures, the molds, presses, and machines must be built to withstand great stress. This naturally sets up rigid limits on the size of a part that can be produced by either injection or compression molding. While, theoretically, there is no reason why a small boat, for example, cannot be compression molded, the cost of molds and presses increases at a disproportionate rate as size goes up. Thus, compression molding of a boat becomes prohibitively expensive.

With impression molding, on the other hand, molds and equipment can be made in large sizes without increasing the cost to an impractical point; this follows naturally from the fact that only low pressures are involved. The ability of this method to utilize light molds made of wood, sheet metal, or cast resin makes

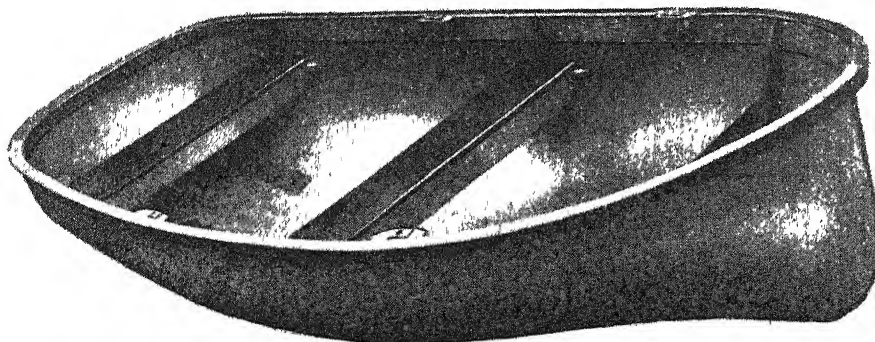
• LOOKING AHEAD •

Decorative plastics wall panels will be made in large unit sizes. . . Plastics luggage will invade the medium-price field. . . Boat hulls will be made in one piece. . . Adoption of impression molding will call for new designs offering new advantages. . . Advancing technology will open many new fields to this important plastics development.

possible the production of short run or experimental parts—usually prohibitively expensive in compression or injection molding where steel molds are standard equipment. Of course, steel molds can be used also for impression molding where fairly large production runs are in view.

During the war, when impression molding received its most extensive application to date, cost was not a controlling factor. As a result, the methods that were developed now seem to use a lavish amount of hand labor—and hand labor must be kept to a minimum if impression-molded products for civilian use are to be more than expensive specialties. Economical operation of an impression-molding plant will depend to a large extent on efficiency in handling, laying up, and moving raw materials and finished products which are apt to be bulky and large in unit size.

R. W. Crawford and I. B. Nathanson of Product Development, Plastics Division, Monsanto Chemical Company in a recent evaluation of the place of impression molding in civilian life found that the most successful method of judging where



Courtesy Monsanto Chemical Company

With low-pressure molding, one-piece molded boat hulls become economically practical

and how this process would find widest use was to consider individual fields and individual applications in relation to present materials and alternates

PANELS—Wall paneling promises to be one of the first uses to which impression molding will be put on a commercial scale. The special advantages will lie in the fact that such panels can be made continuously—not limited, as in high-pressure laminates, by the size of the press platens—and that they can be produced on a much shorter cycle than can high-pressure panels. The ease of application and economy of these panels should broaden the field for decorative plastics laminates.

Present impression-molded wall-board consists of one or more layers of woven cloth or paper impregnated with a resin content of about 50 percent by weight and cured into rigid panels by a continuous process. While types under development at this time are essentially decorative rather than structural, there is no reason why this type of material should not find use in transportation equipment as well as in building construction. Furthermore, semi-structural and load-bearing panels can be produced using a corrugated



core and phenolic resins in the faces. The utility of these panels is further increased by the availability of flame-proof resins which—when used with inorganic textiles or cotton or rayon—give a fire-resistant laminated product.

BOATS—One of the fields in which the practicability of impression-molded products is being intensively studied is that of boats. The particular advantage of this process here is that it makes possible the con-

struction of one-piece hulls. Already, boats are being produced from sisal fiber treated with low-pressure phenolics, and experimental work is being conducted using a sandwich-type structure with a honeycomb plastics core. No interior structural members are contemplated in this hull. Of course, the practicability of impression moldings in the marine field can only be determined from actual service records which will take several years to compile after a number of boats have been fabricated and placed in use.

LUGGAGE—There is no better proof of the utility of the impression-molding process for luggage than a new suitcase that has just made its appearance on the market. Introduced in the medium-price field, this traveling case, produced by the Foreval Plastics Company, makes use of six different materials. The core for the sandwich structure is expanded cellulose acetate, produced by E. I. du Pont de Nemours and Company, Inc. The inside skin and one outside skin are Fiberglas cloth, a product of Owens-Corning Fiberglas Company, while the second outside skin is a glass fiber mat turned out in various colors by the Glass Floss Company. The adhesive used in gluing the strips of the sandwich are Bakelite urea-formaldehyde resin; the resin used to impregnate the glass cloth and glass floss skins is a styrene copolymer made by Bakelite Corporation. The vinyl chloride extruded bumpers and scuff-proof corners are also a Bakelite product.

The finished weight of this suitcase is 5½ pounds. But, in addition to its light weight, it has eye appeal as well as high strength and abrasion resistance. Of course, impression moldings of any type cannot compete in the lower price

bracket, where the largest luggage volume lies, with bags made of low-grade plywood covered with varnished cloth

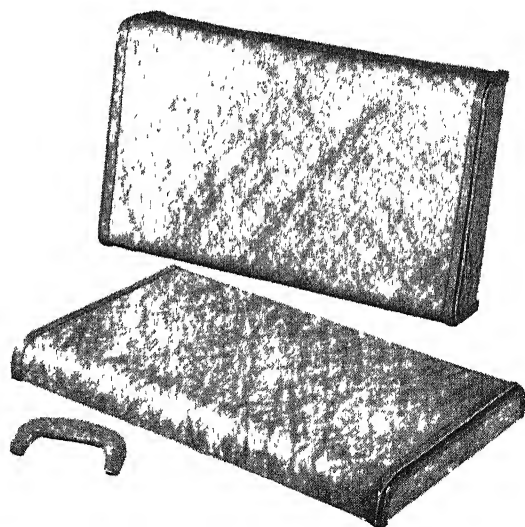
VERSUS METAL—The competition which impression molding must meet in the toy field is with drawn and stamped sheet steel. Since such things as the bodies for express wagons can be stamped out of medium-gage steel sheet at low cost, it is unlikely that impression molding will offer enough important advantages over metal to justify what would without doubt be a higher cost.

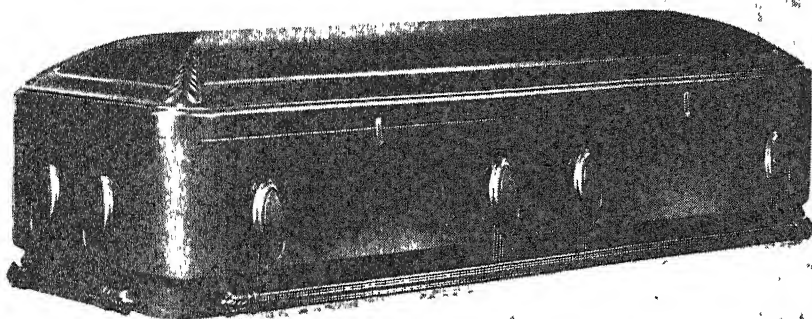
It would seem, then, that the opening for impression molding in the toy line will come from the development of entirely new playthings. Of course, there are a few exceptions to this, as in the case of doll carriages which can well be designed for production by this new method to sell somewhere near the price now charged for wooden or woven-wicker doll carriages and similar units that command relatively high retail prices.

Again, in the automotive field, the competition is also with stamped and drawn steel parts. It would seem that impression molding has not much chance, on a price basis, for such parts as fenders, door panels, and so on. This is particularly true in view of the fact that steel is an accepted and proved material for these end uses. However, it is possible that impression molding may find applications in such auto-body work as station wagons, which are now put together virtually by hand, and present indications are that it will be used experimentally in at least a few parts of some of the new conventional cars.

PROS AND CONS—There are many other possible uses for impression molding in refrigerators, radio cabi-

Light traveling bag (left) is made of low-pressure type laminates. Its sections (right) have cores of an expanded cellulose acetate, are covered with glass-fiber cloth and glass-floss skin. Plastics adhesives and small parts bind the whole together





Courtesy Columbia Rope Company

Impression molding produces fine finishes as seen on this plastics casket

nets, caskets, tables, and bookcases, to name but a few. Except in such cases as inner shell units and door liners for refrigerators, the most important stumbling block to the adoption of this new process in these varied applications is the question of public acceptance of the rather radically new designs which would be necessary to adapt the parts to impression molding.

Then there is the lighting field, which holds promise of making good use of impression-molded articles. It is entirely feasible that with a proper choice of filler and use of transparent resins, light transmission and diffusion can be controlled to meet specific design specifications. Shields of this type would share with other plastics the quite obvious advantages of light weight and ease of installation and cleaning.

It would seem that rumors of impression-molded sink basins, bath tubs, and toilets are still very much in the future. All indications are that presently available laminates do not have the high water resistance necessary for them to withstand long immersion at frequent intervals.

However, the true test of what fields will successfully adopt impression molding, and what fields will not, can come only as products are created and tried out. And much of this work will be done within the not too distant future.

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PLASTICS SEALS

*First Expand
Then Contract*

SEALING the ends of metal tubes against air, water, or dust, and, perhaps, sealing the ends of other types of products is accomplished by the use of special vinyl compounds which are first extruded in the form

of tubing. This is then cut and crimped at various lengths for sale as sealing caps or cut and sold without crimping for ultimate use as sealing sleeves.

Sold with the plastics pieces is a solution in which the plastics caps or sleeves must be soaked for a five-hour period prior to use. In the solution they expand half again as large as their normal size. While still dilated they are placed in position over the tube where they shrink to form an airtight fit.

The water-resistant material was developed to keep dust and moisture from the interiors of metal tubing in refrigerator condenser systems during manufacture. But new uses are cropping up daily. As sleeves they seal the joint between two telescoping tubes in condenser systems. Or their bright colors (red, blue, green, yellow, orange, white, and transparent) may dictate their use as lead markers for wires and cables. Good insulation properties make them ideal as coverings for bus bars, wire cleat insulation, and noise dampeners on machinery.

Special heat-resistance requirements can be fulfilled by different formulations of the compound. The caps can be crimped or the sleeves cut at any length, with a trade mark added if desired, and can be pro-



After soaking five hours in dilator, seals slip on easily, shrink to fit

duced to specified diameters and thicknesses to meet the individual needs of the manufacturer. The plastics and methods of use were developed by General Electric Company.

SMALL BRUSHES

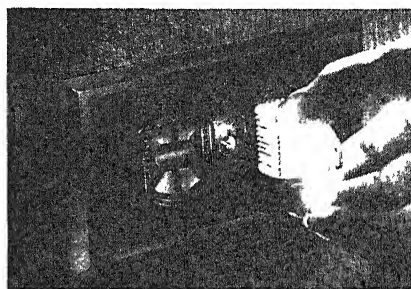
*Now Made with
New Synthetic*

BRISTLES of vinylite monofilaments are the latest element in the brush field. First appearing in nail brushes, they are expected to be used in a variety of other small cleaning brushes.

NIGHT LIGHT

*Has Plastics Case, Uses
But Little Electricity*

WHILE it won't serve as a beacon to guide you home on a dark night, Nite-T-Lite, which consists of a



Plug-in safety light

1/10-watt bulb enclosed in a translucent Styron case that plugs into an ordinary light plug, will light the way into darkened rooms. Manufactured by Little-Fuse, Inc., this attachment gives off a soft glow without using much electricity. The advantage of the ribbed polystyrene case is that it will withstand very heavy handling yet is easily assembled with the other components of the light.

COLORFUL

*Heavy-Duty Plastics for
Household Appliances*

WHEN washing machines, vacuum cleaners, electric irons, and sterilizers are once more in free supply, the chances are that a large proportion of the agitators, housings, and other parts will be produced in a range of standard colors from a new shock-resistant melamine-formaldehyde molding compound developed by the American Cyanamid Company. Tough enough for heavy-duty applications, this Melmac 3020 can be produced in the colors which are so important to the public acceptance of plastics. White, blue, green, red, and ivory molding compounds are immediately available.

Successor to the Sextant

Loran, a Far-Flung Mesh of Radio Position-Lines Marking the World Air and Sea Lanes like Numbered Streets and Avenues, Bids Fair to Supplant the Venerable Chronometer and Sextant with a Cathode-Ray Tube. Handicaps to Celestial Navigation Have No Effect on Loran

By HARLAND MANCHESTER

OUR C-47 took off from Floyd Bennett Field, Long Island, set out in an east-northeasterly direction, and was quickly engulfed in the fog. No land could be seen. We were headed for Charlestown Airfield, Rhode Island, and our only guide was an array of dancing green streaks on the glass cathode-ray screen of a little black box. The pilot had been told to obey nothing else.

At the navigator's table Lieutenant Commander Read showed me a new kind of aerial road map. It was covered with intersecting lines which diced coast and sea into roughly rectangular chunks. Each line bore an identifying number. These were not the familiar imaginary lines of latitude and longitude. They were much more tangible. They were really there where the map showed them to be. The "electronic fingers" from the little black box reached out and found these highways, and the dancing green streaks counted out the numbers on their route markers.

Commander Read touched his pencil to the map. "We're heading down this line," he said. "We'll stay on it past Montauk Point, then when we get to this intersection off Block Island, we'll make a 90-degree turn to the left and follow that line to the Rhode Island airport."

Down the line we flew, as casually as though we were driving along a parkway and planning to turn north at Route 7. Now and then Read manipulated knobs and got a "position fix" to keep us on the course. Soon he made a cross on the line opposite Montauk.

"That's where we are," he said. We couldn't see the Point, but we took his word for it. He turned the knobs again and two hairpin-curves of light stood side by side on the scope. They edged closer together.

"When they overlap," he said, "we'll be at the intersection."

Soon they matched, and Read told the pilot to make a left turn. A few minutes later we dropped through the overcast to about 500 feet. There

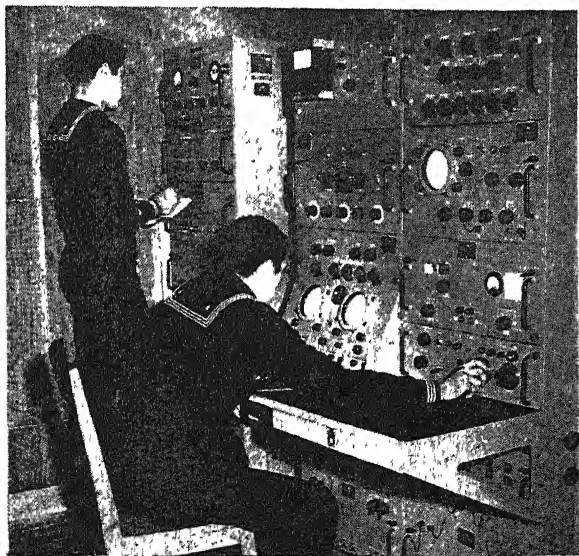
• LOOKING AHEAD •

With an eye to the day—yet to come—when men will challenge the sky and the seas without fear of the elements, science has forged a worthy weapon in Loran . . . Its implications, extending beyond the more obvious ones of safety and convenience, are of prime importance in air-shipping where payloads must always bow to the fuel margins needed for safety. . . And afloat, the Loran maps are as significant as the works of Bowditch; the mariner is no longer forced to grope along on dead-reckoning when the skies are obscured.

was the airport. After 150 miles on these invisible streets, figuratively "painted on the air" by radio pulses, we were only 100 yards to the left of the airstrip.

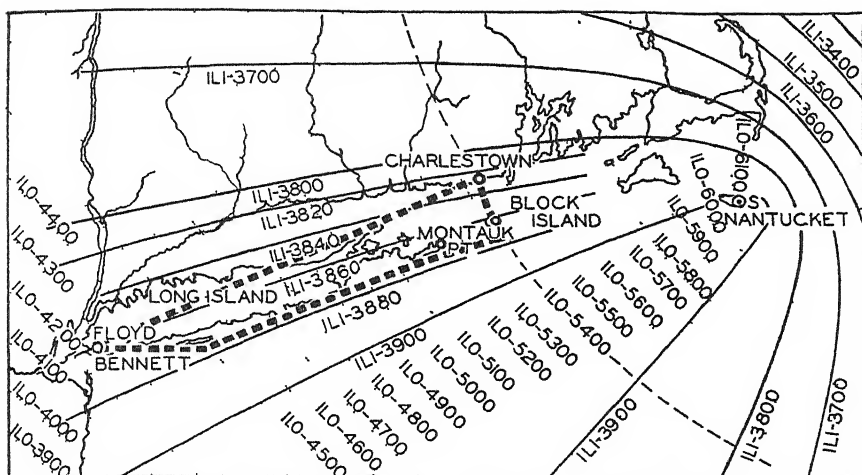
This is Loran, (short for LOnG RAnge Navigation) one of the greatest triumphs of the American physicists who pooled their talents to fight the Axis. Before Loran was brought forth by M.I.T.'s great wartime research center, the Radiation Laboratory, navigators on ships and trans-oceanic planes had to "shoot" the sun or stars and calculate their positions in the traditional way. This took so much time that it was not geared to the needs of fast-flying planes. When weather blacked out celestial bodies, even that aid was gone. Fuel was wasted, planes were endangered, and operations were limited. Radio beams, radar, and other systems have been used in various ways for position-finding, but no other electronic method combines the range, precision, and reliability provided by Loran. Loran tells the navigator where he is, in three minutes or less, and operates 24 hours a day in all weather.

Ten years ago, Loran was technically impossible. Five years ago, it was incredible. Yet before the end of the war, 3000 ships and 30,000 planes were navigating by Loran's



Interior of Loran transmitting station where operators maintain constant watch on timing equipment. About 150 such installations could cover the main travel routes of the world

United States Coast Guard photo



Path of flight described in article. By paralleling ILI-3880 line until just after intersection with ILO-5400, navigation was simplified. On return trip, in clearer weather, pilot diagonaled (see upper broken line) across Loran lines

vast network of radio-highways which, in effect, are fixed permanently in the air. Lines like those we followed to Rhode Island now gridiron most of the Atlantic and the Pacific, covering more than 40,000,000 square miles of the world's navigable waters.

Attracted by its war-time record in saving lives, fuel, and craft, post-war commercial vessels and trans-oceanic airlines are rapidly adopting Loran. The *Queen Mary*, the *Queen Elizabeth*, and the *Gripsholm* use it regularly, and all over-seas planes of American Airlines System, American Overseas Airlines, Trans-Canada, and Royal Dutch Airlines depend upon it. The basic principle of Loran can be set forth fairly simply.

HOW IT WORKS—To begin with, Loran has nothing to do with radar. The super-short waves of radar, some of them no longer than a cigarette, travel in straight lines like light waves and dash off into space when they reach the horizon. Consequently, while radar waves can reach the moon, the earth's curvature limits their ordinary service range to about 250 miles. Long radio waves, which hug the earth's surface, are essential to Loran. So 160 meters (the old amateur band) was selected. These waves provide "highways" which reach out over the sea as far as 800 miles in the daytime and 1600 miles at night.

Loran sending stations operate in pairs, and anyone with a bathtub can find out how a station pair sets up the fixed highways which now girdle much of the globe. Dip both forefingers simultaneously into the water a few inches apart and you set up two circular patterns of ripples. If you watch closely, you will see that, while the ripples move steadily outward, the points where the

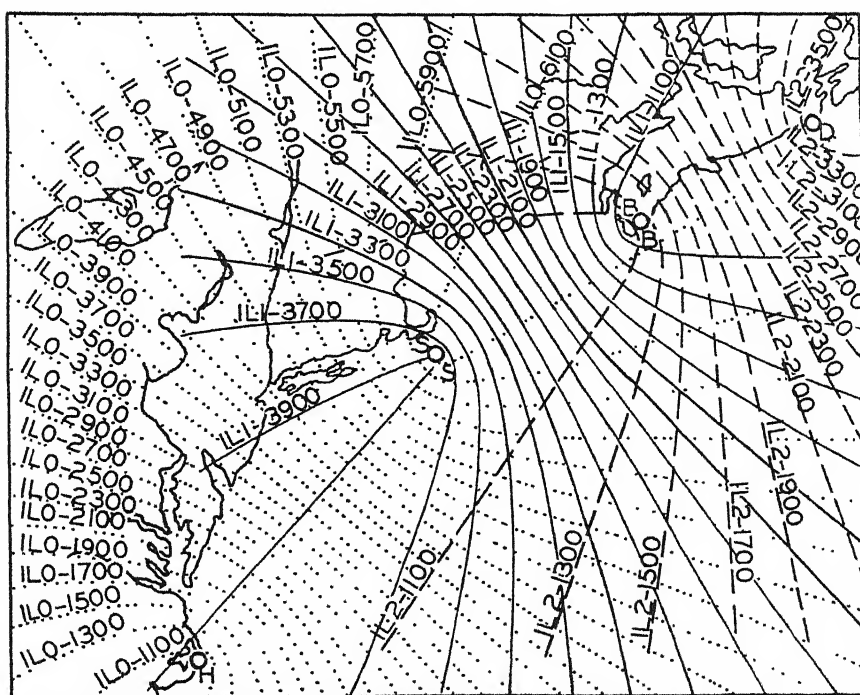
ripples intersect one another appear to remain stationary. The ripples sent out by Loran's twin radio pulses behave the same way, and the numbered Loran "highways," which appear on the millions of new navigation maps, are simply hyperbolic lines drawn through these apparently stationary intersection points. Thus, a method has been found of taking radio waves which travel at 186,000 miles a second, and making them seem to stand still.

Each Loran broadcasting team is composed of a "master" and a "slave" station, located 300 to 400 miles apart. The master leads off in emitting short bursts of radio energy, only 40-millionths of a second long, and the slave, triggered pre-

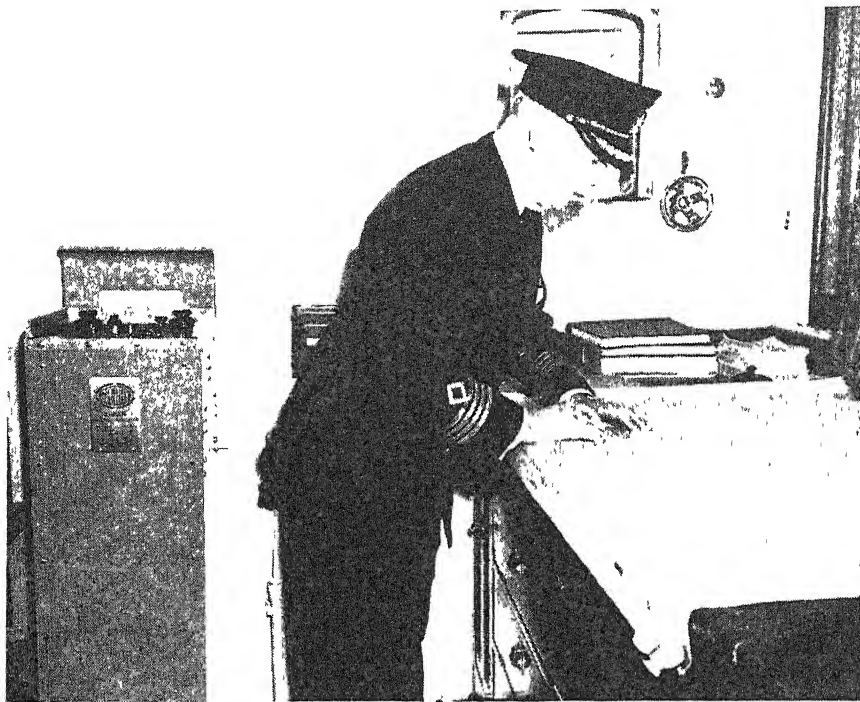
cisely by the impulses from the master, follows suit a known fraction of a second later. This slight delay prevents the possibility of having two highways marked by the same signals, and makes the station signals easier to identify.

Soon after our take-off, Commander Read selected on the dial the most convenient station pair in the area, the team broadcasting from Nantucket and Nova Scotia. A procession of upright green lines marched across the scope. Using a trick borrowed from television, Loran dishes up radio signals so that you see them on a cathode-ray screen, instead of simply hearing them. Each line represents a different Loran station, just as you have a choice of many stations on your home radio. Two of the lines stood still. This was the pair he had chosen. Turning knobs to project on the screen a series of graduated scales, Commander Read quickly added up the difference between the two time signals and jotted down the result, which was 3878 millionths of a second. Then he looked at the printed Loran map and found the highway nearest to his reading. It was labeled "3880," and we were just a bit north of it. Since a single Loran reading shows only the highway on which the plane or ship is traveling, but not the exact spot on the highway, a second reading is necessary.

To get his second "fix," Read selected Cape Hatteras and another Nantucket station, whose lines in-



Section from Loran map of north-east coast of United States. Area from which map at top of page was taken is located just above ILI-3900. Note hyperbolic radiation of Loran signals and way in which intersections give fixes on lines of position. Actual maps use colors, not broken lines, and are more complicated



Courtesy Sperry Gyroscope Company, Inc.

Using newest Loran receiver (left), Captain H. G. Nordenson plots the course of the *M/S Gripsholm* on Loran chart. Wide commercial use of Loran is expected.

intersect 3880 at an angle. Their green signals promptly halted for measurement. He could now mark our exact position on the map. The whole job had taken him less than a minute. Whenever the wind blew us off our chosen Loran line of flight, the error was easily corrected by another reading. Even when the weather cleared on the home flight, the navigator didn't bother to check our position by looking out of the window. Loran was easier and quicker, he said.

TIME IS ESSENCE — What makes Loran possible is the amazing preciseness of its timing equipment. It is an electronic scalpel which slices time into millionths of a second, a stop watch which freezes these incredible fragments in their tracks, and a projection machine which turns them into visible symbols that any trained man can interpret. It has been calculated that a clock of comparable accuracy would run five to ten years before it would lose or gain as much as a single second.

This accuracy was reflected in its everyday war-time use. Pacific pilots, homing to San Francisco, knew that if they followed Loran line 2055 they would pass over the north end of Golden Gate Bridge, while if they hopped over to 2075 they would cross the south end.

One war-time Loran line ran from the American air base in the Marianas some 1400 miles to Tokyo, and B-29's rode it back and forth in their "shuttle-service." With a well-marked path to follow, they left

their customary reserve fuel at home and were able to add as much as a ton and a half to their bomb loads.

A ship stationed off the Aleutians kept its position accurately through two weeks of foul weather by means of Loran. Plane carriers off Okinawa, when weather barred celestial observation for three days, used the vibrating green lines to hold position for homing fighters. Half a dozen Loran stations gave good service guiding planes across the "Hump" between Burma and China. And in the Atlantic battle against submarines, Loran was widely used to enable a ship and a plane to keep a rendezvous.

BEGINNINGS—Loran got its start in November, 1940, when the National Defense Research Committee decided to try out a suggestion made by Dr. Alfred L. Loomis, the versatile genius of Tuxedo Park, New York. A chain of four stations, stretching from Delaware to Greenland, began operation in the fall of 1942. They were an immediate success, and the Navy set up training courses for station operators and navigators. Much equipment used in actual service was built by research men in the Radiation Laboratory, then large orders were placed with manufacturing firms. The first airborne receiving set came in two units, weighed 75 pounds. Later both bulk and weight were halved, and the present one-piece set weighs 35 pounds.

Meanwhile, in England, R. J. Dippy, a former school teacher, had

been pioneering independently in a British version of the system, identical in principle, called "Gee." Mr Dippy's position lines were much shorter than Loran's but they aided the RAF in flights over Europe. While the Radiation Laboratory profited by British experience, Loran can be fairly called an American invention.

Loran's greatest value is for guiding ships and planes over vast, unmarked stretches of ocean, but a special system called SS ("sky-wave synchronized") Loran was developed during the war to throw radio streets over land. During the final months of the war in Europe, the Germans learned how to detect tell-tale signals from planes which used radar. So SS Loran, which could not be spotted because the sets in the plane only receive, do not broadcast, was used for the night bombing of Berlin and other targets. Since the signals of SS Loran travel by bouncing sky waves, the method is effective only at night when sky waves are strong.

V-J Day found the Radiation Laboratory scientists experimenting with a new Loran system designed to give coverage simultaneously over land and ocean areas. A chain of three experimental stations was installed on the east coast which covered most of the United States east of the Mississippi and a large part of the Atlantic. Navigation tests by the Army and Navy were successful. These stations were moved to western Canada to guide the snowmobile caravan of Canada's "Exercise Musk-Ox" in its 3000-mile scientific trek through little-known Arctic terrain. The 47-man expedition, which set forth on February 15, was fueled and provisioned almost daily by a fleet of planes. Loran gave the explorers their exact position, which they radioed to air bases, enabling the planes to drop supplies within a quarter of a mile of the caravan.

WORLD ROAD MAPS—An essential part of the Loran project has been the printing of 2,500,000 big, elaborate "road maps," in which the labeled radio highways appear in various colors for easy recognition.

In the office of J. A. Pierce of Harvard, former head of the group of scientists which developed Loran at the Radiation Laboratory, I saw a master map of the world dotted with 70 red pins, representing Loran broadcasting stations whose gridiron of navigation lines nearly girdles the globe. In the conversion from war to peace, some of these stations are being dismantled and others installed where they will best serve

peace-time traffic. One of the appealing features of Loran is its relative cheapness. The cost of the war-time system is generously set at \$130,000,000, and that includes research and development and the building of some 40,000 receiving sets which became surplus goods when the war ended. It is estimated that a network of about 150 stations would be enough to cover all the traveled areas of the sea, and the air above it, throughout the world. Each station would cost about \$100,000 to install, and the maintenance of the whole system might run to \$20,000,000 a year. International cooperation will, of course, be necessary, and world-wide standards were discussed in a conference in Dublin last March.

IN WAR AND PEACE—Loran gear was whipped together quickly in response to war's demands, and despite its remarkable service, it can already be called obsolete. New Loran equipment which is even more accurate and easy to use already exists. Sperry Gyroscope Company has started delivery of sets to the Navy in which readings are fully automatic, eliminating all chances

of human error in adding figures. The navigator selects a station pair and the set does the figuring, showing a "highway number" which can be found at once on a Loran map. And this is only the beginning.

Like most new inventions, Loran can do its part in making any future war more devastating, and Mr. Pierce recently startled the Institute of Radio Engineers with an awe-inspiring picture of pilotless aircraft and bombs directed to their targets on Loran's accurate "highways." A Loran line can be thrown at night to cross any target within 1600 miles, he explained, and an intersecting line can be set up over the target to release the projectiles for descent. Bomb-loaded aircraft could be dispatched independently from dozens or hundreds of launching sites toward this line, to which their Loran receivers would be sensitive. When they reached the "highway," each would alter its course and ride the line to the target.

But the great future of Loran is in guiding peace-time traffic. Girdling the globe with its invisible streets, it is bound to make travel faster, safer, and cheaper in the years to come.

ern tip of South America. Present figures indicate only 6,100,000 foreign registrations of American-made cars.

The article tells of people in Peru fitting parts from one car into another, and car parts into trucks. Tubular metal bedposts were used for parts, and gears were cut out of pieces of steel, using hand saws and files in efforts to keep cars going.

Europe's need for motor vehicles is great, and the market for American machines girdles the world, Mr. Stanford's article points out.

SPOT-WELDER CONTROLS

Built as Units, Boost Multiple-Welding Speeds

A NEW welder-control unit is said to permit automatic-assembly welding rates up to 900 spots per minute. Designed to meet the requirements for fully automatic multiple-spot resistance welding of a large number of joints quickly and in one operation, the control is claimed to reduce the production limitations of such welding to the time required to load and unload the welding machine.

Called the Ultra-Speed unit, the control distributes welding current to a single welding point or to groups of points successively by means of a screw-driven carriage that depresses push rods to engage contacts in a manner similar to running a finger over a piano keyboard. At the same time, another element of the carriage engages adjustable-stroke plungers to control individually the length of time the welding current flows for each weld. All welding points bear on the work simultaneously under welding pressure before the first weld is formed, and remain until the last weld is completed, eliminating

LIGHT PLASTICS

Will Float on Water, Retain Flexibility

AMONG the plastics developed by Dow during war-time for secret military uses and for cable sheathing, Styraloy has properties which place it in the field between rigid plastics and rubber. It is lightest in weight of all Dow plastics—it will float on water—and its flexibility at low temperatures is an outstanding characteristic.

When combined with synthetic rubber, Styraloy imparts more flexibility at low temperatures, better electrical properties, and lower water absorption. It also provides more uniform flow and better surface finish, which means lower fabrication cost.

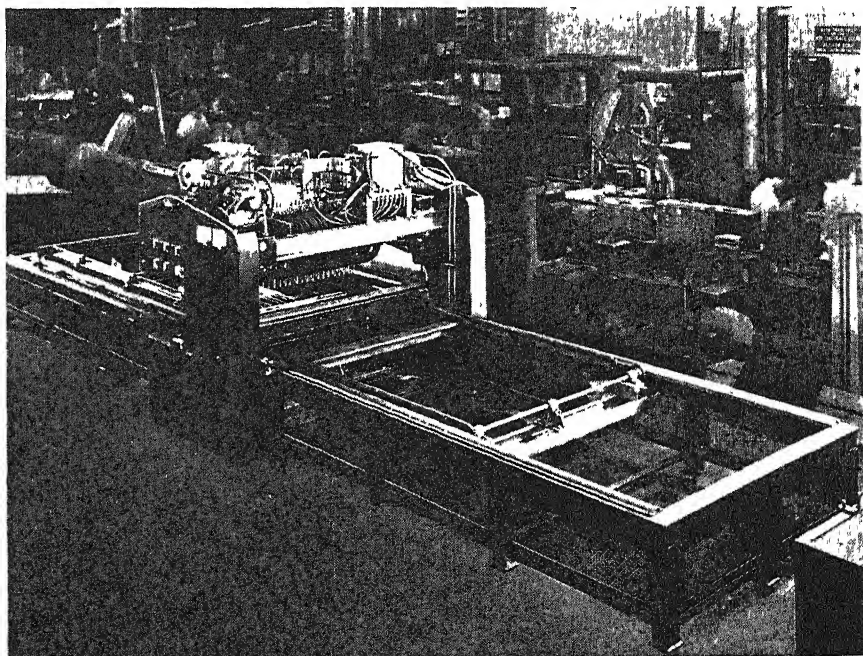
AMERICAN-MADE CARS

Needed in Huge Numbers to Meet Foreign Demand

WAR-TIME losses created a tremendous international market for automobiles, and in 10 to 20 years the world's pre-war car population may be nearly doubled, according to James Stanford writing in *Ethyl News*, publication of Ethyl Corporation. Moreover, the whole western hemisphere "is nearly 100 percent American in its automotive prefer-

ences," and many of the other nations also prefer machines made in the United States.

To sell and service the 14,300,000 overseas vehicles in use in 1940, car dealerships and service stations extended as far north as the little Finnish city of Rovaniemi, inside the Arctic Circle, and as far south as the Chilean town of Porvenir in Tierra del Fuego—the islands off the south-



Welding current feeds to single points or groups of points automatically

the separate "squeeze" and "hold" times usually required for each weld. Thus 20, 50, 100, or more joints can be made in slightly more time than the total of the individual "weld times"—at a few hundredths of a second each. Unit construction of the control, built by the Progressive Welder Company, permits combination of such units to accommodate as many welding guns as required for various assemblies.

VISION CHECKING

*Speeded by New
Sight-Screening Unit*

INDUSTRIAL efficiency and safety will be promoted by a new vision-checking program which quickly spots those employees who need an eye examination and correction, according to the American Optical Company, who have instituted the program in their own plants.

Dr. Paul Boeder, director of the company's Bureau of Visual Science, says that the program was developed on behalf of industry because surveys disclosed that one out of every three industrial workers is handicapped by deficient vision which costs American industry millions of dollars in production and other losses. "Industrial eye accidents," he declares, "cost \$20,000,000 each year in direct compensation and medical expenses, and inefficient eyesight is responsible for many of the industrial accidents which cost \$400,000,000 annually."

Pointing out that most industrial operations demand efficient vision, it is said that inspectors and engravers should have keen eyesight, machin-

ists and assemblers of precision parts need good eye coordination because they use their eyes at close range over long periods, and drivers of motorized equipment should possess good depth perception to perform their work in safety. When employees lack the necessary visual qualifications for specific jobs the result may be lowered production and increased accidents.

Detection of the visually unfit under the new program, it is explained, is made with the aid of a newly developed sight-screening instrument which utilizes polarized light to check vision. The device is portable and can be carried directly into a factory for checking each employee's visual performance.

Data on 14 different visual functions can be obtained through the device in three or four minutes. From this information the eyesight specialist determines the employee's need for eye care, particularly as it affects his job. If required, a complete eye examination is then provided so that the employee receives the benefits of the necessary professional services essential for developing visual efficiency, safety, and general comfort.

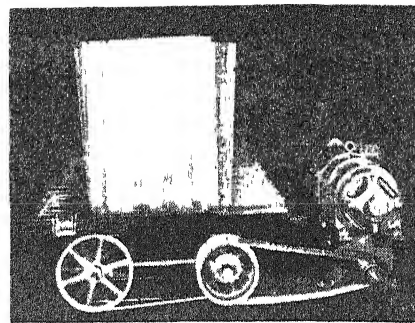
Dr. Boeder reports that American Optical's new plan for promoting industrial safety and visual efficiency also includes the development of visual programs designed to meet the specific needs of different industries, promotion of investigations to establish visual-placement standards for various job classifications so that an employee's eye capabilities may be better utilized; and recommendations for improving environmental conditions affecting vision, such as poor illumination, glare, smoke, and fumes.

TEST TABLE

*Proves Packaging by Simulating
Freight-Car Motions*

VIBRATING and shaking like a freight car, even to the pitch and toss, to test packages and products to be sure they will arrive in good condition and will "work" without home tinkering, a new test table will give the equivalent of a coast-to-coast freight trip in a one-hour test.

Two eccentric shafts, one under each end of a strong table, cause the table to vibrate with a circular motion in a vertical plane, and with a displacement about the same as the maximum deflection of average freight car springs and at a frequency similar to their natural frequency. The shaft at one end of the table can run either synchronously or out of phase with the shaft at the other end, or at a different



Packages get equivalent of coast-to-coast freight trip in one-hour test

speed. As a result, the table has a mixed motion and a "pitch and toss" in addition to its vertical and horizontal movements. The rhythm is similar to freight cars. The package repeatedly bumps a fence secured to the table, giving it shocks similar to car bumping or train jerks. Smaller packages may be stacked or larger boxes strapped down to duplicate actual freight car loading methods used.

INSECTICIDES

*Play Vital Role in
Human Affairs*

INSECTS will inherit the earth unless man abandons war and turns his martial energies to killing pests, Dr. H. L. Haller of the United States Bureau of Entomology and Plant Quarantine warned in a recent address delivered before the American Chemical Society. Pointing out that in the United States alone, insects destroy about one tenth of each year's food and fiber crops, Dr. Haller estimated the annual loss as two billion dollars.

Speaking authoritatively as chief chemist of the Entomology Bureau's Division of Insecticides, Dr. Haller declared that despite great advances in insect-destroying techniques, 20 percent of America's annual cotton output has been ruined in the last decade by six of the more common insects attacking this crop. "Likewise," he continued, "four of the more common insects attacking corn have reduced the average per acre yield of this crop by 13 percent. Much the same situation exists with respect to vegetable and fruit crops."

Not all insects are harmful, however, Dr. Haller noted. In fact, he said, of the 600,000 known species only about 6000, or 1 percent, are considered dangerous, and of these only about 70 kinds are responsible for most of the agricultural losses in this country. Insects are agents of pollination of many flowers and hence are responsible for the growth of a large group of fruits and vegetables. He further noted that some insects kill others which are harm-



Fourteen eye functions are tested in a few minutes. Portable checker saves time, does not take employee from job

ful, and that some form important sources of chemicals such as beeswax, cochineal, silk, and shellac.

In view of these facts, it was emphasized that man must learn to live with insects in general, while attempting to control or eradicate those dangerous to his food, economy, and health.

Discussing the various types of chemicals used to control pest and plant diseases, he named lead and arsenic compounds as the major agricultural insecticides, and copper, sulfur, and mercury compounds as the chief weapons for guarding crops against fungi. The war-time development, DDT, will find considerable use in both agricultural and household insecticides, Dr. Haller predicted. Since the use of inorganic compounds such as arsenic and lead may leave residues that constitute health hazards, the trend in the development of new insecticides has been directed towards utilization of organic compounds.

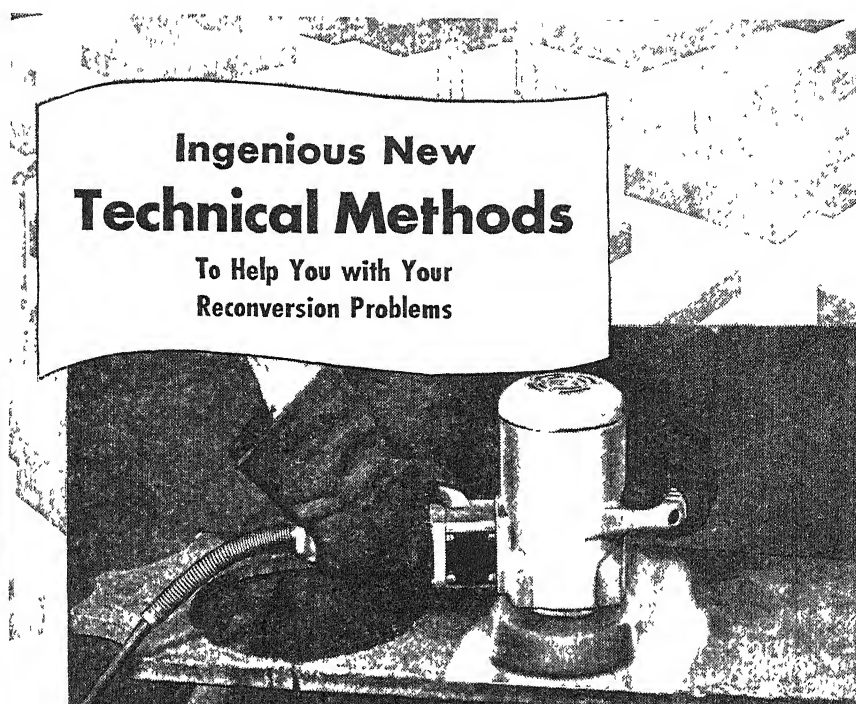
Organic, or carbon-containing, insecticides may be divided into three broad classes—those of animal origin, those of plant origin, and those prepared synthetically—he continued. The first class consists of fish oils, glue, and petroleum oils; the petroleum oils being most important. Of several hundred plants tested for insecticidal properties, Dr. Haller reported, only a few have shown enough promise to be of commercial value, the most important being tobacco, pyrethrum, and the rotenone-bearing plants, derris and lonchocarpus. Although DDT has received the most attention among the new synthetic insecticides, another, named benzene hexachloride, has been found very effective against certain pests.

LATEX FOAM

Will Find Many Industrial Uses

EXPERIMENTATION and development in the rubber industry has produced a material known as latex foam with a multitude of uses ranging from seating and sleeping cushions to fracture padding for medical use, W. L. Jantzen of United States Rubber Company said in an address at a recent meeting of The American Society of Mechanical Engineers. Comparing the latex foam with other types of spongy rubber, the speaker said:

"The important difference is that the latex foam is completely porous—the skin surfaces of latex foam are filled with tiny pores just like human skin—and the internal structure of the material is a homogeneous mass of interconnecting air



New Portable Grinder Lasts Longer ... Increases Production

The **Portable Gaston Grinder** is designed for the grinding and sanding of metal—also, with wire brushes, for paint and rust removal. Because it is powered by a 3-phase motor, without brushes, commutators or gears, the Gaston will give long service.

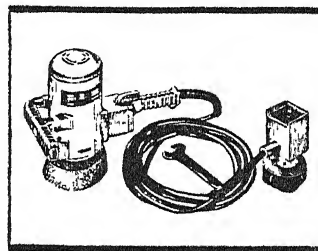
The Gaston Grinder starts at full speed. Its speed remains constant regardless of extra pressure by the operator. This controlled speed under heavy load, eliminates glazing of the grinding wheel, produces a better ground surface.

Three sizes of dust-tight Gaston Grinders are available. Furnished in either "cup-wheel" or "edge-wheel" type, as desired.

In a dusty work atmosphere, that causes throat irritation and dryness, chewing Wrigley's Spearmint Gum helps keep workers' mouths moist and fresh—thereby reducing work interruptions—and "time out" to the drinking fountain.

Workers can stay at their machine, while chewing Wrigley's Spearmint—even when their hands are busy. There is no lost time. And the pleasant chewing helps keep them alert and wide-awake. One Connecticut manufacturer with a dust problem reports group production up about 3% over normal, when workers were given chewing gum. Other plants and factories everywhere, claim stepped-up efficiency when chewing gum is made available to all.

*You can get complete information from William H. Howland
2533 East 73rd Street, Chicago 49, Illinois*



The Portable Gaston Grinder



AA-68

cells. Thus the latex foam is porous through and through—water will run through it, air easily passes through it and to prove this you can blow smoke through it. This perhaps is one of the chief reasons for its success and adoption for seating and sleeping—it is able to completely dissipate body heat."

Application of the material to seating purposes revealed that its supporting qualities make unnecessary the use of solid material, cores of appropriate size being run through the latex foam, the speaker said. He noted also that, while the texture does not permit use in the uncovered state, tests have shown that

fabrics wear better over such cushions than on conventional cushions. The material also may be combined with springs.

Discussing uses for latex foam other than seating, the speaker said:

"In the sheet form and of soft density it is being used as fracture padding by doctors and hospitals. It is used in operating table and examination table pads. It is molded into invalid ring cushions and bed pillows. It served as lining in metal helmets during the war; it provided cushioning for sights in certain telescopic instruments; it provided linings for cases housing delicate instruments."

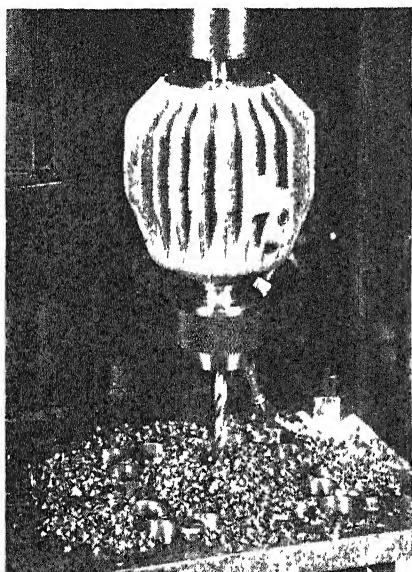
New Products and Processes

CHIP BREAKER

*Frees Drill for Deeper
Cutting, Eliminates Hazard*

INTRODUCED as an aid to longer drill life and higher operating speeds, an improved drill chip breaker operates at each revolution of the drill. In operation, the short chips accumulate around the mouth of the hole, eliminating the long, whirling spirals that would otherwise be thrown about the machine. Drill coolant is said to flow readily past the broken chips.

Advantages claimed for the Ex-Cell-



Long, spiral cuttings are eliminated

O Drill Chip Breaker include: faster drilling, rounder and smoother holes, less drill breakage from chip-clogged holes, greater safety, and the elimination of periodic drill withdrawal to clear chips.

As described by the manufacturer, the unit may be used in either vertical or horizontal positions and, where space permits, on multiple spindle heads.

POINTING COMPOUND

*Repairs and Waterproofs Brick
and Concrete Surfaces*

AVAILABLE in large quantities for industrial use, and in convenient smaller quantities for applications around the home, a new cement pointing compound can be applied at putty consistency or thinned out and used as a waterproofing wash. It dries quickly and is reported to seal repaired exterior surfaces completely against water.

This new material, known as "Brix-Fix" and developed by the Greater

New York Waterproofing Company, is produced in four colors—red, gray, white, and black—so that repairs can be made to match the surrounding surface. To use, the dry powder is mixed, as it comes from the container, with water to attain the required consistency. Heavy mixtures are applied to holes, cracks, and voids with a trowel or pointing tool; thin mixtures can be brushed on.

Plant maintenance men and home owners alike will find the compound easy and convenient to use, since all necessary ingredients except water are ready mixed. After all loose mortar is removed from the surface to be repaired, the area is thoroughly wet down with water and the mixed compound is applied. After drying, it can be painted if desired.

MASONRY BLADE

*Improves Cutting of
Construction Materials*

ABRASIVE masonry-cutting blades that are said to overcome objections to earlier blades have recently been placed on the market. Advantages claimed for the "Jade" blade, made by Champion Manufacturing Company, include: longer life, lower cost per cut, quick cutting, and elimination of operator eye-strain. The blades are offered in 12- and 14-inch sizes.

CIRCULAR SAW

*Has Magnesium Frame,
Passes Through Doorways*

A LIGHT-WEIGHT portable 12-inch radial saw, made principally of magnesium, weighs approximately 200 pounds complete with carrying frame and 1½ horsepower electric motor. Its compactness allows it to be carried through a 30-inch doorway. With a



3 by 16-inch crosscut and 20½-inch wide ripping capacity, it is reported that the portable saw will handle the kinds of work usually done by heavy stationary saws.

The American Saw Mill Machinery Company states that the Monarch Uni-Point saw's main feature, in addition to lightness, is its "one-point cutting" principle with which the saw blade always travels through the guide fence and cuts the lumber at the same point on the table. When making a cut, the saw assembly and hardened-steel arm move forward on ball-bearing rollers. At the completion of each cut, the assembly moves back and the entire table top is clear for layout, measuring, and so on.

Permanent accuracy of the entire machine is said to be maintained by five simple adjustments, and because operating adjustments are kept at a minimum, it is claimed that the saw will save considerable time on the job.

INDUSTRIAL TIRES

*Made of New Synthetic,
Resist Floor Contaminants*

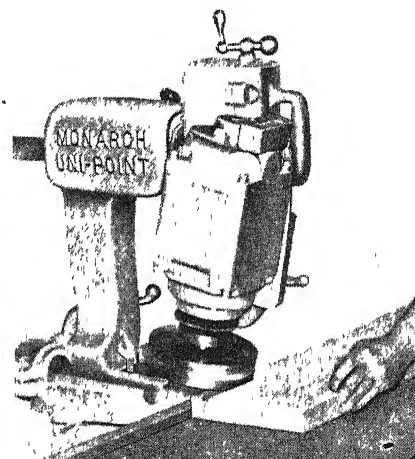
IN ADDITION to resisting the destructive action of oils, greases, and brines, a new synthetic rubber compound for industrial tires is reported to have less rolling resistance than regular construction industrial tires. As compared with either natural or GR-S government synthetic rubber tires, The B. F. Goodrich Company says the new synthetic stands up better against cutting and chipping.

DETERGENT

*Comes in Concentrated
Form, Cleans Many Materials*

A NEW multi-purpose car-wash and household cleaning agent is a synthetic detergent derived from petroleum and free of animal and vegetable fats, greases, or acid. It is non-inflammable.

On automobiles and other vehicles, the product, called Ethyl Cleaner, is



Attachments (above) permit notching, routing, shaping, sanding, dadoing, boring, and like jobs. Light-weight frame adds portability—saw may be taken to job (left) by its operators

described as equally effective for wind-shields, windows, upholstery, chrome fixtures, tires, canvas tops, and the metal body

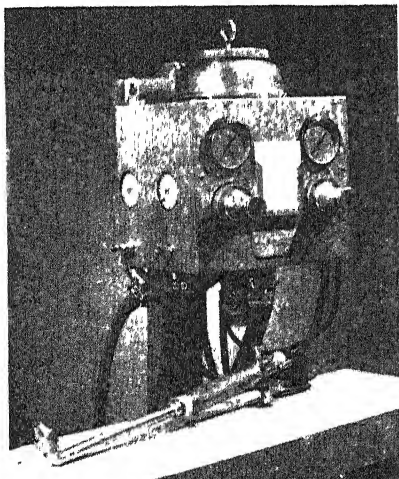
Among the home uses for which its manufacturer, the Ethyl Corporation, recommends of painted, enamelled, and porcelain surfaces and finishes, as well as tile, windows, refrigerators, stoves, upholstery, and rugs. It is also recommended for washing fine woollens since the detergent leaves no scum or other residue.

Ethyl Cleaner is offered in concentrated liquid form, a 24-ounce bottle produces about 120 quarts of cleaning solution when water is added to it. Mild to the skin, the cleaner contains no abrasives or caustics, does not attack surfaces or finishes, and is said to clean readily in any temperature or type of water. The new product also appears to possess unusual "wetting out" qualities which permit it to saturate the article or surface being cleaned very rapidly.

FLAME TOOL

Projects Flux-Alloy Mix
in Controlled Atmosphere

UNUSUAL welding and metal- or plastics-surfacing processes may be accomplished with a new flame tool



Torch will weld, braze, metalize, or apply plastics or hard-metal surfaces

made in the general outlines of an ordinary welding torch. The torch has a special nozzle and 16 independent controls, many of them at the handle of the tool. A control box with air- and gas-pressure regulating valves, and a canister from which powdered materials are fed through the flame make up the rest of the equipment.

Known as Powder Weld, the equipment is described by the maker as "a new method of welding, brazing, or surfacing with infinite compositions of powdered materials." Super-hard metal coatings and various types of plastics are said to be quickly and easily applied with the device.

Complete control over all variables in the process—amount of flux, amount of flux-alloy mixture, flame temperature and atmosphere, processing gas temperature of projected material, and

so on—makes possible a great variety of results

Typical applications for which Powder Weld is described as being suitable are surfacing with plastics or synthetics enamels, powdered-alloy brazing, powdered-metal welding, rod welding with projected fluxes, controlled-atmosphere welding, and metal spraying.

PLASTICIZERS

Offer Advantages
In Many Coatings

TWO NEW plasticizing resins for use in metal, wood, fabric, and paper coatings, and with plastics and wax compositions

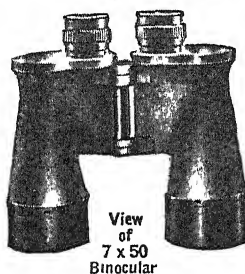
are known as 276-V2 and 276-V9; they are the first of a new series of styrene resins to come from research done in the Dow laboratories.

The company, describing them as water-white, non-yellowing viscous liquids which are chemically inert, said that they possess an attractive combination of properties, are soluble in all common organic solvents except the lower alcohols, and are compatible with a wide variety of film-formers and plasticizers. The workability of these new resins with waxes, and their resistance to alkali were particularly pointed out as greatly expanding their use.

Good electrical properties, ready

SENSATIONAL WAR BARGAINS in LENSES and PRISMS

NOW! MAKE YOUR OWN



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Complete Set of LENSES
and PRISMS from
Navy's 7x50 Model

SAVE up to \$150!

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6159-S*	23	51	1.25
6161-S	24	48	1.25
6162-S	25	122	1.25
6164-S*	26	104	.80
6166-S	29	54	1.25
6168-S	29	76	1.25
6169-S	31	122	1.50
6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	63	1.10
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6179-S*	46	78	1.25

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solubility, alcohol and chemical resistance, lack of acidity, and stability on aging will make these new plasticizing resins useful in plastics and calendering compositions, bronzing lacquers, paper lacquers, textile coatings, pressure sensitive adhesives, emulsions, and rubber compounds as well as conventional lacquers, the company said.

STABLE IRON

*Used in Improved
Precision Flat*

A SURFACE plate of improved design is made of a specially alloyed close-grain iron to assure the utmost stability

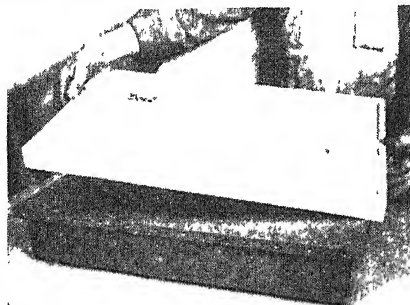


Plate edge has fixture-mounting holes

in the finished plate. Careful annealing and treatment by alternate heat and extreme cold at various stages in production is said to impart a stability formerly obtained only by long periods of natural aging outdoors.

The 14 by 24 inch DoAll surface plate is constructed with a system of ribbing to support the working surface; the number of ribs, their placement, and depth are engineered, it is reported, so as to prevent any appreciable deflection in normal use. Three feet, positioned to ensure a minimum of sagging, support the plate.

The flat surface is pin-point hand-scraped with 22 or more evenly distributed bearing spots per square inch. Maximum deviation of the bearing areas from a mean plane is .0002 inch over the entire surface. The underside of the $\frac{3}{4}$ inch overhang on the plate is machined all around. Thus, work or fixtures can be clamped to the surface plate. In addition, the edge of the working surface has been drilled and tapped on 2 inch centers all around to enable the user to mount special fixtures.

ARC WELDER

*Does Versatile Job
On Rural Power*

AN ECONOMICAL welder for rural power lines, which simplifies welding and increases its utility for average repair and fabricating jobs features an "Arc Booster." When the electrode touches the work, the welding current is given a boost of intensity for starting the arc, and then reverts automatically to the amount set for the job. Either of the two degrees of arc boosting provided is selected by a snap switch, one for general work and the other lower

amount for thin material such as automobile fenders.

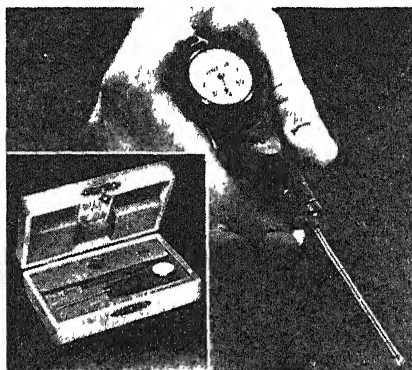
Current control for the new "Fleet-Arc Jr." is of the separate adjustable reactance type and is variable over the entire welder range of from 20 to 180 amperes by turning a hand wheel. The new unit, manufactured by The Lincoln Electric Company, is for 230-volt, single-phase power lines and meets the limited input requirements of rural utilities and REA because of high efficiency and a high power-factor. With a maximum input current of 35 amperes, the 360-pound welder can be used with the standard 3-KVA power transformer provided by the power company. Current range is from 20 amperes at 20 volts to 180 amperes at 25 volts welding duty, and electrodes may range from 1/16 inch to 5/32 inch diameter.

INSIDE DIAMETERS

*Checked Visually By
Small-Hole Gage*

A DIAL indicator gage has recently been announced that will gage holes between .122 and .250 inch inside diameter, in depths up to $2\frac{1}{4}$ inches. Variations within the diametrical range are obtained by a set of 12 interchangeable gaging plugs.

With this new small hole gage, internal defects—taper, out-of-round, bell-mouth, and so on—are immediately visible on the indicator dial, thus giving a better visualization of the



Hardened steel ball in gage tip rides on hole walls to check contour errors

condition than is possible with a conventional plug gage. When calibrated and set for a specified inside diameter, the gage has a total range of plus or minus .004 inch in minimum graduations of .0001 inch. The dial is balanced and can be rotated.

Made by Federal Products Corporation, the new gage is said to be capable of measuring a range formerly beyond the scope of the dial indicator.

PORTABLE PLASTICS MELTER

*Gives Tools "Dip" Protection
Anywhere in Plant*

PLASTICS protective coating of plugs, gages, carbide-tipped tools, and so on may now be accomplished at any location in a plant with a new portable melting tank of one-gallon capacity. According to the manufacturer, Aeroil



Melter uses lighting circuit power

Products Company, this tank allows the plastics compound to be brought to dipping temperature, from a cold start, in minutes instead of the hours normally required for equipment of this type.

The tank, called the Midget-6, features a one-piece inner vat of heavy, warp-proof, cast-aluminum of high heat conductivity. The special design of the unit is said to result in complete uniformity in heating the critical plastics coatings.

Other features include accurate thermostatic controls to automatically maintain heat at required temperature; removable cover with insulated plastics handles; neon pilot light; and a carrying handle for portability. The complete unit weighs 16½ pounds.

The portability of the 1000-watt equipment is aided by a two-prong plug which fits standard lighting outlets—no special fuses or wiring is necessary. The equipment can be set up anywhere in the plant, so that the processing can be brought to the parts to be coated rather than vice versa.

PATTERNED METAL

*Gains In Appearance
and Strength-Weight Ratio*

DESIGN-ROLLING of patterns into ferrous and non-ferrous sheet and strip metal is a new process that offers the advantages of decorative textures, improved strength-weight ratios, and increased utility values. Called Rigidizing,



Resistance to mars and finger smudge adds attractiveness to metal objects

the treatment gives metals finely-textured patterns providing directional, non-directional, or three-dimensional effects for decorative interior and exterior applications such as panels and trim in architectural work, transportation equipment, appliances, and so on.

Some Rigid-Tex Corporation patterns are designed for increasing stiffness and impact strengths without materially increasing the unit weight. To date the greatest field for the use of Rigidized metals is reported to be in utility applications such as acoustics, illumination, and heat transfer.

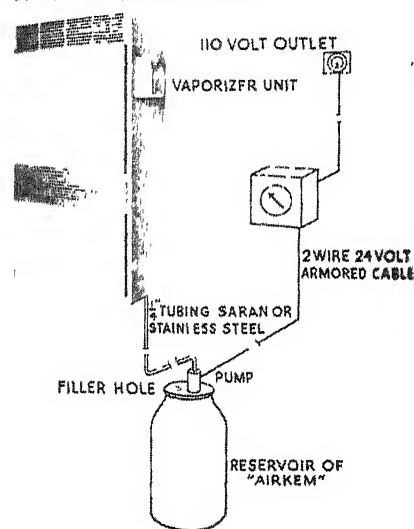
Other uses are anticipated where attractive textures that mellow light and hide such surface imperfections as finger prints, scratch marks, and so on are important.

AIR DE-ODORANT

Dispensed Through Air-Conditioner, Portable Unit, or Wick-Bottle

FOR ODOR control and air-quality improvement in industrial plants and other enclosed spaces subjected to occupancy and industrial odors, a new system

ANY TYPE OF AIR CONDITIONING SYSTEM OR UNIT



For use with air-conditioning systems

of dispensing Airkem-chlorophyll air freshener—has been announced. First used in hospitals, this odor counter-actant and air-freshener is now supplied to large motion-picture theaters, hotels, restaurants, beauty salons, schools, and so on. Airkem has also been adapted to industry where undesirable odors are likely to slow up production.

Airkem is reported to be composed of a complex group of aromatic substances from plants, plus activated chlorophyll; the dispensing devices volatilize these aromatic substances and thus bring objectionable odors under control. The activated chlorophyll gives a pleasurable outdoors effect to the air. Enclosed spaces serviced by air-conditioning units can be de-odorized by the Evapatriol system, an installation which may be fitted to existing air-conditioning or ventilating systems. Non-air-conditioned areas may utilize either the

RADIOBIOLOGY

Experimental and Applied

BIOLOGICAL EFFECTS

F G Spear

COMPARATIVE STUDIES

L H Gray

GENETIC EFFECTS

D G Catchside

VIRUSES AND BACTERIA

D E Lea

HISTOLOGICAL ANALYSIS IN RADIOTHERAPY

A Glucksmann

MEASUREMENT OF RADIATION

G J Neary

TOTAL ENERGY-ABSORPTION

F Ellis

METHODS IN X-RAY THERAPY

J Read

METHODS IN RADIUM THERAPY

S Rus

MILLION VOLT THERAPY

G S Innes

PROTECTIVE METHODS

W Binks

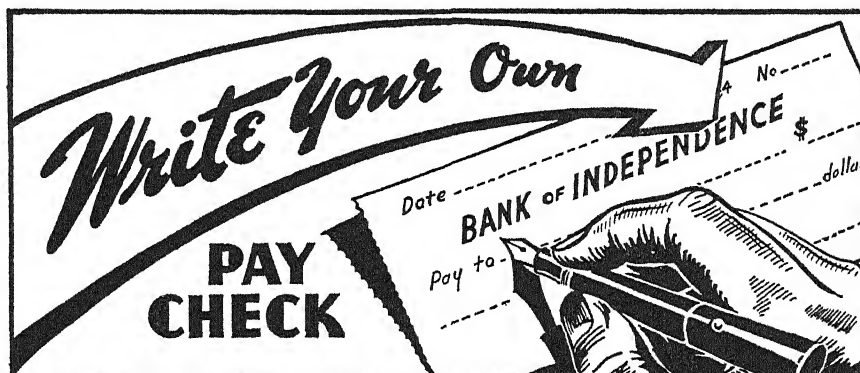
EXCHANGE OF DATA

J Read

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This Symposium is No. 1, Volume 4, British Medical Bulletin, (80 pp. and cover, seven shillings). Copies may be obtained from the publishers; Medical Department, The British Council, 3, Hanover Street, London, W. 1, or from booksellers

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Airkem portable Evapatrol unit or evaporation from a 15½-ounce bottle, equipped with the special wick.

When used with air-conditioners, whether of the central or the packaged self-contained type, the Evapatrol unit consists of a reservoir of Airkem, in which is a pump, a regulator, and a vaporizer. The pump forces the deodorant into a nozzle in the vaporizer from which it is sprayed out over a cartridge holding excelsior. Some of the air of the air-conditioning unit bypasses through this cartridge and evaporates and mixes the air freshener into the conditioned air. The portable type differs from the other units distributed by W. H. Wheeler, Inc., in that the supply of Airkem which is evaporated is thrown into the air by a motor-driven fan.

BINDERY GLUE

*Based on Plastics Resin,
Has Permanent Flexibility*

BECAUSE of its resistance to extremes of temperature and climatic conditions, a liquid plastics synthetic resin is adaptable for use as a cold padding glue in print shops and binderies.

The use of plasticizing agents is said to overcome troubles due to crystallization, hardening, and brittleness, and also to impart greater covering qualities. According to the manufacturer, Paisley Products, Inc., one gallon of the glue, called Platab, will cover two hundred square feet of padding area. The compound, which features long storage life and permanent flexibility, can be applied by hand brushing or spray gun, and is available in red and white.

STEAM CLEANER

*Combines Portability with
Operating Simplicity*

AN ECONOMICAL steam-cleaning unit that operates from a standard plant steam supply is said to give a powerful cleaning action through the use of heat, water, detergent, and friction. Weighing only 28 pounds, the unit is portable, and couplings permit fast connection. Steam lines maintaining 80 to 150 pounds pressure, with ¾ inch valve outlets are usable with the cleaner.

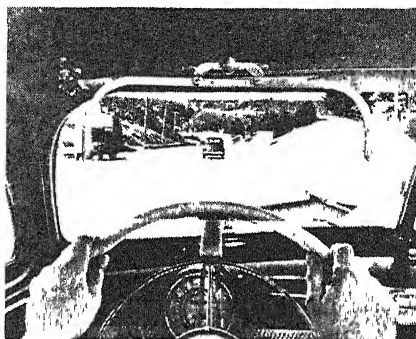
Three manual controls vary the temperature, quantity of solution, and

nozzle pressure to fit the needs of the job at hand. Turco Products, Inc. describe the Hydro Steam Unit as adjustable to deliver a high-temperature, penetrating spray, or a moderately warm spray. Other features are ease of operation and the absence of moving parts, pumps, pressure tanks, motors, electrical connections, and toxic or explosive cleaning agents.

DRIVING VISOR

*Reduces Motoring Fatigue
by Blocking Road Glare*

RELECTED sun glare, a common source of eye-strain and driver fatigue, is said to be efficiently screened out by a new light-polarizing automobile visor. The driving aid, called the Polaroid Day-Driving Visor, is designed to be suspended in front of the motorist's eyes. Made of a curved, polarizing-plastics



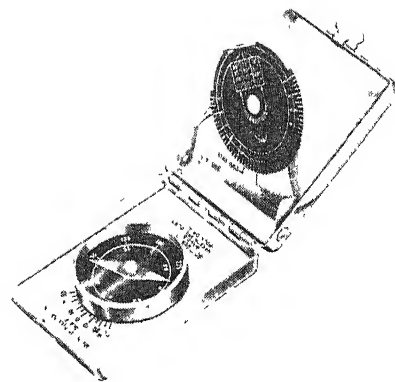
For day-time use, pushes up at night

sheet, the visor is supported by a lightweight steel frame which attaches the unit to the car and allows it to be swung up out of the way when not needed. It is claimed that the special properties of the Polaroid material exert a selective control over the light reaching the driver's eyes.

SUN-WATCH

*Has Luminous Compass Needle;
Needs No Winding*

A POST-WAR version of an ancient horological device is now offered to sportsmen in the form of a compass and sun-watch combination that tells both time and direction accurately. The Boyd "Sun-Time" is intended for use when fishing, hunting, sailing,



Time and direction told accurately

camping, hiking, skiing, or motoring. No winding or setting is necessary.

Described as waterproof, compact, and durable, the device has a solid brass case which houses a compass with an unbreakable crystal and a luminous jeweled needle.

PICTORIAL DRAWING

*Done Faster, More Accurately
with Angle-Ellipse Stencils*

TO SPEED production of the three-dimensional type drawings now widely used in many industries, two new sets of draftsman's pencils have recently been placed on the market. One set of stencils provides the correct axes for isometric drawings; the other set is designed for drawings with axes at dihedral angles.

Both sets incorporate edge graduations for scaling the work in hand, and each stencil has 27 ellipse openings, correctly projected and ranging from ⅛ to two inches in diameter. The larger Hi-Range Instrumaster Stencils provide ellipses of greater diameter. All ellipse openings are marked as to the size of circle represented and carry center lines for locating purposes.

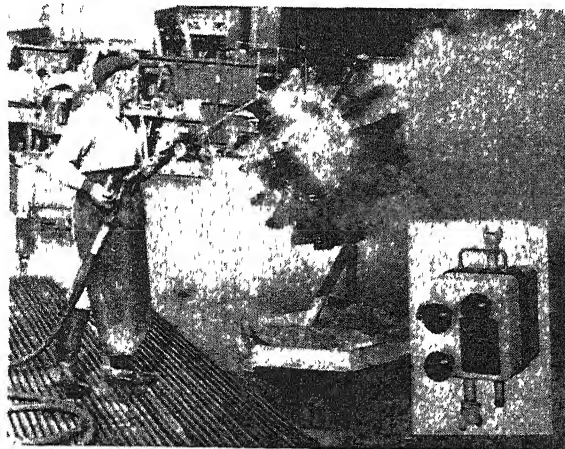
The stencils, manufactured by Instrumaster Industries, are made of clear plastics stock .040 inch thick. Graduations and lettering are debossed on the lower surface.

PRECIPITATOR

*Provides Clean Air
for Industry or Home*

AIRBORNE dust and dirt, a serious handicap to precision manufacturing, are said to be efficiently reduced with a new electrical dust eliminator. It is claimed that lower maintenance costs, higher efficiency, and greater comfort and safety may be achieved with this device, called the Raytheon Precipitator.

Used to remove smoke, dust, pollen, oil mist, and other contaminating particles commonly found in fresh and recirculating air systems, the unit appears adaptable to metal, textile, precision instrument, food, pharmaceutical, and other industries. Another industrial application is the cleaning of re-circulated air in forced-ventilation rotating machinery systems.



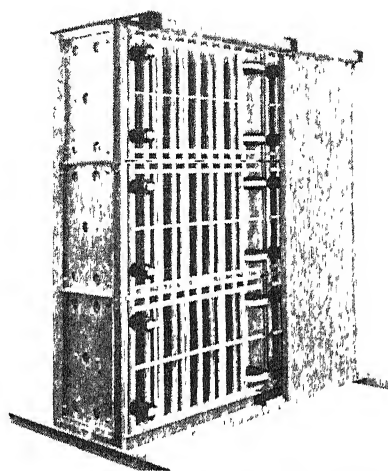
Non-explosive and
non-toxic
cleaning agents are
used in unit
that connects to
shop steam
lines with single
valve fitting

Domestic users may incorporate the Precipitator in the heating and ventilating systems wherever practicable, or small individual floor units that plug into the lighting circuit may be used.

Electrostatic dust precipitation involves passing all airborne particles through an electrostatic field and subsequently precipitating the charged particles onto oppositely charged collector plates.

The Raytheon device consists of three principal parts—the dust-collector cell, the ionizer unit, and the power supply. The ionizers are energized by the power pack with high-voltage direct current to create a strong electrostatic field. The collector plates are periodically washed down to remove the dirt although, on some units, washing equipment will be completely self-contained.

A 1200 cubic feet per minute Precipitator is said to be able to clean, by recirculation, the air in a room ap-



Ionizer and collector cell unit. Cell variations match capacity to air flow

proximately 35 by 35 by 12 feet, and with a ¼ horsepower motor blower, is enclosed in a cabinet measuring 26 by 27 by 54 inches. Standard 115-volt, 60-cycle power is used and it is reported that power consumption is 50 watts per hour or less than that consumed by the average reading bulb. A Precipitator of this size, with the installation of suitable duct work, is described as suitable for removing oil mist from high-speed cutting tools.

BENCH MILL

Offers Big-Machine Features

ADAPTABLE to many jobs, the new Armor milling machine, is reported to accomplish accurate and high-speed production work, as well as intricate tool work, even though reduced to the size of a bench-type mill. It weighs 320 pounds, stripped.

Eliminating the use of a knee by means of a rise and fall spindle the mill has both horizontal and vertical spindles, and precision adjustable bearings. A fully automatic power feed is available which drives the table in either direction through a reversible gear box for feeds from ¼ inch per

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For Shop Home and Farm

Winner New Product Award by "Mill & Factory Magazine"

POWER-ARM gives amazing extra leverage. LOOSENS tight, rusted screws easily. TIGHTENS any screw so it stays tight. LOCKS against handle for ordinary driving.

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Pronounced "DIE-ACK-RO"

O'NEIL-IRWIN MFG. CO.

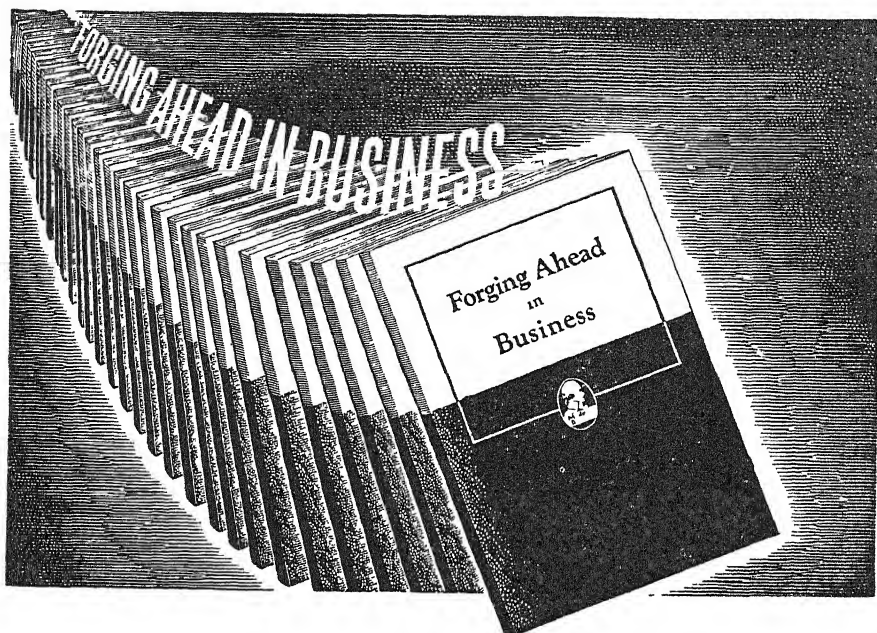
4,000 Parts Per Day with DI-ACRO Bender

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Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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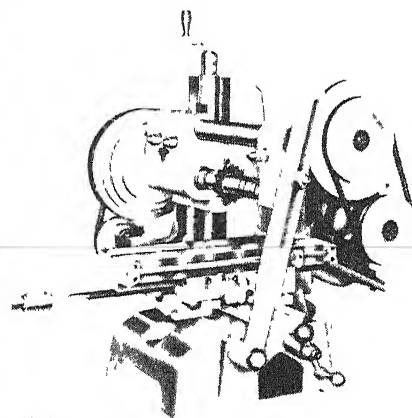
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Weights 320 pounds, has automatic feed

minute for high-speed mill cutters through 32 steps to a 15 inch feed for carbide-tip cutters.

Eight spindle speeds provide a range from 98 to 1140 revolutions per minute through double-belted, cast-iron pulleys. The back-gear accessory provides a low spindle speed of 33 revolutions per minute. A one-horsepower motor or smaller can be used if desired.

Made by Aircraft Machinery Corporation, the mill has a travel of 12 inches longitudinal, 10 inches vertical, and 7 inches across. Two types of heavy-duty vertical attachments are offered to convert the horizontal machine into a standard vertical milling machine.

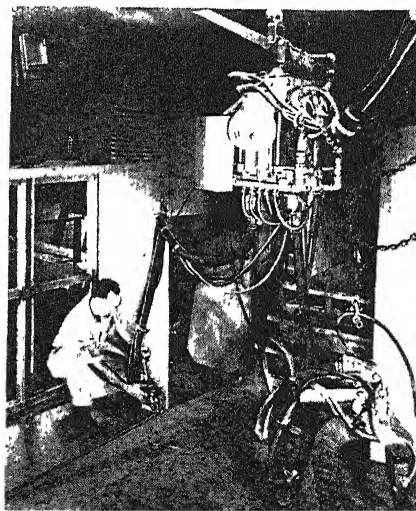
SPOT WELDER

Moves to Job via
Overhead Hoist System

USE of a single portable installation for spot welding is one method which may help small plants to lower the unit cost of products to a point of economical competition with larger factories.

One such installation, used at Vering Manufacturing Company, consists of only two welding guns operating from a single transformer and with a single timer and air-hydraulic booster.

The entire assembly travels on a mono-rail chain hoist, thereby permitting the welding equipment to be moved quickly over a wide area and raised and lowered at will for welding



Small plant gets wide use from welder

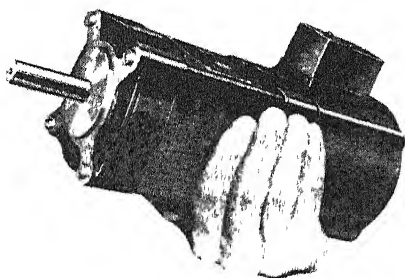
in different positions. One of the welding guns has a short throat and the other a deep throat to permit reaching all the joints of the assembly.

This portable dual welding gun unit, made by Progressive Welder Company, is said to have reduced production times and costs and also eliminated drilling, bolting, and reaming.

15-POUND MOTOR

Develops Two Horse Power for Continuous Duty

EXTRA-COMPACT and light, a two horse-power explosion-proof motor of the continuous duty type is now available for use in railroad, marine, aircraft, and special industrial applications. With an armature speed of 9000 revolutions per minute, the motor can be supplied for any output-shaft speed. An integrally built gear reducer, used where lower speeds are required, adds two pounds to the basic weight of 15 pounds. An enclosure helps to render



Features heat-resistant construction

the motor safe for use in hazardous locations.

Construction features of the motor, made by Electrical Engineering and Manufacturing Corporation, are ball-bearings, glass insulation, and high-temperature insulating varnishes. Variations in models permit operation on 28, 32, or 110 volts, d.c.

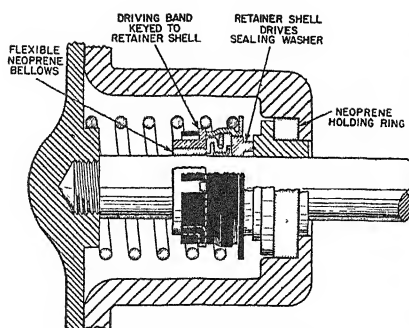
SHAFT SEAL

Compensates for Wear and Misalignment

A LONG-LIVED shaft seal employing neoprene, recently announced, is expected to reduce the expense of repeated re-packing of pumps or glands.

The seal assembly consists essentially of a low-friction sealing washer of bronze, carbon or hardened steel, and a seat of cast iron, bronze, or nitralloy as required to give best service with the sealing washer selected. The sealing washer is driven by the shaft; the seat is stationary. The two are lapped together to give an absolutely smooth surface; both are then floated on resilient neoprene supports to compensate for misalignment, wear of sealing washer, shaft vibration, and end play. A neoprene bellows is used to float the sealing washer, while a neoprene cushion ring is used for the seat. A strong spring is used to force the sealing washer against the seat.

The driving end of the resilient neoprene bellows forms a seal between the shaft and the driving band. Force



Resistant to oil and chemicals, seal material is resilient and long-lived

is also transmitted to the metal parts which turn the sealing washer, thus allowing the neoprene bellows to advance freely and maintain a seal as the sealing washer wears from contact with the seat.

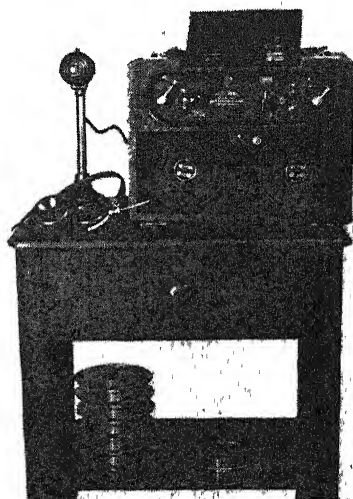
Neoprene, made by E. I. du Pont de Nemours and Company, Inc., was selected for this shaft seal because it is a resilient material which retains its original properties for long periods, resisting the deterioration caused by oils, refrigerants, and most chemicals. Thus, the manufacturer can apply this shaft seal to a wide variety of uses.

SOUND-ON-FILM

Device Takes Dictation, Usable for Public Address

EQUIPPED with an electro-magnetic head, which serves the dual purpose of recording and reproducing by means of a diamond pointed stylus, a new recorder indents up to one hundred sound tracks across the width of a special film. A numbered dial automatically shows the number of the track on which a recording or playback is located. Originally developed for use as a sound supplement for silent films, the device is now offered in other models for business dictation.

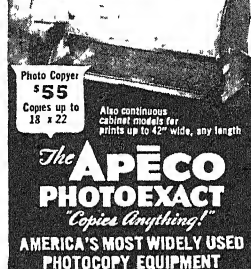
Recordings are made longitudinally on the film and the period of recording on a single sound track is approximately 20 minutes. The film, light in weight, compact, and tough, can be mailed safely and economically since



Recordings are durable, may be played back repeatedly, shipped conveniently

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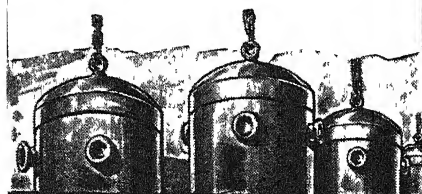
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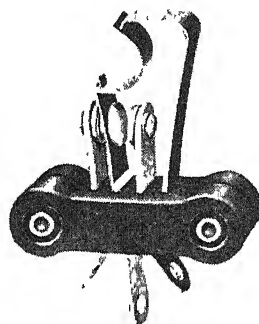
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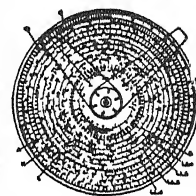
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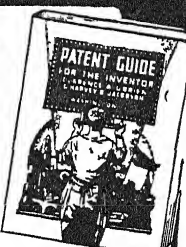
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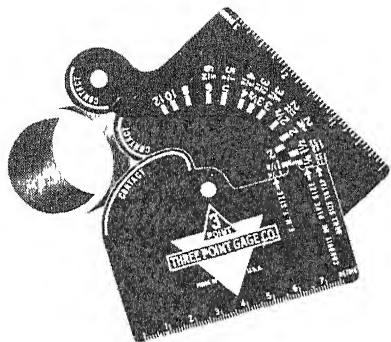
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The manufacturers, the Three Point Gage Company, state that it is necessary to contact only a small section of the pipe contour and that the device will measure pipe in any position, even against a wall or in a corner. It is also possible to measure a covered pipe if there is a small opening where the gage may be slipped in between two pieces of asbestos pipe covering.

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Within the retort, porous refractory cubes which have previously been impregnated with a special catalyst react with the air-gas mixture under a properly adjusted temperature, to pro-

duce the controlled atmosphere. Before entering the furnace muffle, the cracked gas passes through a short cooling tower.

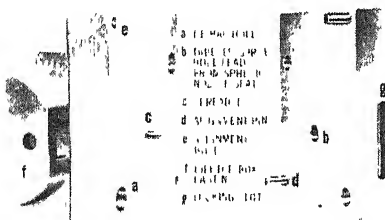
The manufacturers of the generating equipment, Bellevue Industrial Furnace Company, say the arrangement will produce good results throughout an unusually wide range of atmosphere requirements.

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Bring Casting Facilities
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ON-THE-SPOT die casting is now described as available at low cost with a high-speed production die-casting machine that uses pre-fabricated die sets. Blank die sets, available from machine tool dealers, permit manufacturers to make their own dies by simply machining the die cavity and grinding the gate.

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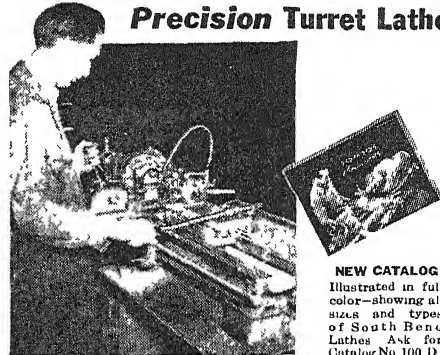
Molds to Close Tolerances;
Is Adaptable To Many Uses

A PLASTICS troweling compound, which can be "tailored" to conform with individual requirements, has been announced by Duorite Plastic Industries. Called "Plastipaste," it is described as being lighter than magnesium, yet stronger than the finest grade of wood. Uses include making tools, heat and electrical insulators, relief maps, art objects, novelties, and containers for various corrosive chemicals.

A phenolic resin, Plastipaste is held to various dimensional tolerances by controlling the shrinkage through regulation of the percentages of "filler" required for its mixing. The filler is a special fiber compound known as Duorite Flox Filler. A catalyst is used as an accelerating compound to cause the resin to harden.

Plastipaste is applied by troweling, and it will readily adhere to wood and other surfaces which are not coated with a wax parting agent. When rapid hardening is desired, complete curing can be effected without heat in about 30 minutes by replacing the regular catalyst with a special one.

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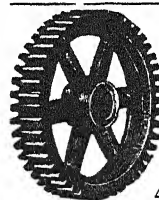
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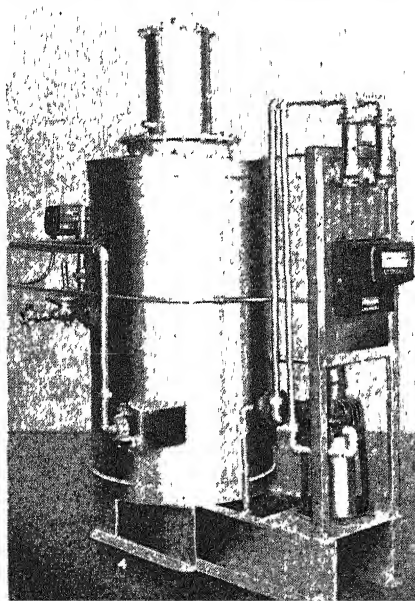
by George W. Pearce

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He then describes how, by the use of various money-saving building methods, a large, modern, 6-room, thoroughly insulated, fire resistant, 2-bath bungalow with garage can be had most anywhere in the United States for \$2800.00.

Included with the book are 10 folded drawings 12" wide x 18" long. These drawings by Mr. Pearce show all the details of construction for this house—the wiring, the plumbing, the automatic oil heating system and the fluorescent lighting. The book is devoted to showing how similar savings can be made on any house of any style, size or floor plan.

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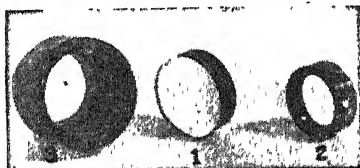
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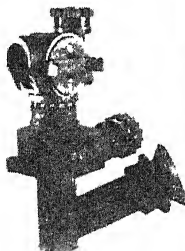
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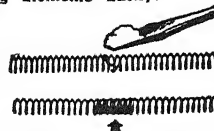
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READERS of this department and friends of Russell Porter—those who have seen him and those who hope to—have asked many times since World War II began what he was doing. Though your scribe has exchanged letters and notes, containing innumerable enclosures of a telescoptical nature, with Porter for 20 years, entertained him at home and been entertained at his home many times, attempts to find out what he was doing in connection with the war just didn't get anywhere. He was under the same seal of secrecy as all who were doing hush-hush work.

With the war over, a campaign of teasing and wearing down was begun on Porter and has at last produced the following response, in reply to the argument that, sometimes, too much modesty is almost immodest. Porter's note

Perhaps, at that, the A.T.M.s might be interested to know what I have been doing since Pearl Harbor when the 200" telescope had to be entirely laid aside. I had expected a comparative holiday for myself while the world was fighting but was amazed to find myself working harder than ever.

As you know, the California Institute of Technology was allocated several war projects to develop, through the Office of Scientific Research and Development, and the officials here soon found that my ability to visualize and put on paper military weapons, before they were actually built and tried out, would many times be useful to them when submitted to the Brass in Washington. I made so many of these drawings—several hundreds of them—that I was finally nicknamed in the capital "The Cutaway Drawing Man."

At first, we here on the Pacific Coast were preparing for invasion by the enemy, and many were the projects put forward to meet it. Later, as our

forces moved into enemy territory, a vast number of offensive weapons were devised and many of them put into production. A major effort was the application of rockets to all kinds of purposes—planes, landing craft, and jungle warfare. "Cal Tech" has already been cited by the Government for its contribution to this effort, and more than one discharged marine has entered my office and spoken almost lovingly of those "jet busters" and how they confused and annihilated the Japs.

It is common knowledge that southern California has been and is a hotbed of proving grounds, scattered in remote areas in the desert, where all these gadgets are tested. A good example is at Inyokern, some 200 miles from here. It is a Naval Ordnance test station and is larger in area than the State of Rhode Island. I spent many days there—just drawing. Here are a few examples of the jobs they threw at me.

Go out and draw a perspective of — Station, taken from 20,000 feet up and looking northeast.

Draw an invasion by landing craft at Guadalcanal, showing an air view of the craft formation, the enemy emplacements and surrounding scenery (Here, for the palm trees and the streams, I levied a good deal on photographs in *Life*, but not wholly.)

Make a cutaway drawing of the fuse in the head of — rocket. This device is as complicated and delicate as a watch and I was hard put to it but finally succeeded. Oh yes, and the drawing must be in tomorrow. "Oh hell," says I, "I'm an old man and the doc insists I take my siesta." "Too bad," they reply, and add, "Take it easy, Porter." Then, as an afterthought, "but the drawing must be in tomorrow." [A masterpiece of understatement through omission. That particular job put Porter in bed for a week.—*Ed.*]

Then there was that fantastic thing, the Jap paper balloon. They had to have one of Porter's drawings showing it dissected. Down in one corner I drew a tablet with four Japanese inscriptions on it. Translated, it meant roughly, "inefficient." They launched some 10,000 of 'em. A few reached our coast but little damage was done.

Then there were those wind tunnels and water tunnels—the latter being glass tanks filled with water into which they shot models of rockets.

Well, it was all pretty much fun in a way. That is to say, interesting. And there were breaks. One night Humason phoned from Mt. Wilson. "Get into your car and up here as soon as you can. Mars is high up in the heavens, and the seeing is fine. "When

I got there the seeing had gone bad but it slowly improved toward dawn I worked at the Cassegrainian focus of the 100" but found no canals to draw. I thought this might displease the astronomers, but, no, quite the opposite."

End of Porter's note and now you know that when they wrapped up the 200" telescope in mothballs for the duration while they turned to the production of war optics they didn't wrap Porter up with it. And since you now are sure to ask about the present status of that job, we have asked Porter to add a word. "The mounting," he writes, "is nearly ready to receive the mirror. The mirror is in the last stages of figuring, and lacks only a few wavelengths of a paraboloid. Mopping up the small odds and ends will take less than a year."

With his war contribution completed, Porter, at 74, is taking some well-earned rest, as shown in Figure 1, which does not, however, show a cutaway of his house. If it did you would see down cellar a neat machine he has designed and built, plugging away on some 8" flats while he reads Porter has sent us a drawing of that machine and promises detailed data on it for a later number.

Throughout his 18 years at Pasadena, Porter has often itched to escape clean-



Figure 2: "But it's also a grand and glorious feelin' to get your hands into a good old job of glass pushing"

handed duties and get into the shop and push glass the same as any other amateur, and has never been so happy as when circumstances permitted his doing it (Figure 2). With all his contacts with the topflight people in science and optics he has never lost that urge. He expects to come to Stollman for the big get-together of amateurs August 3 and 4, there he will give a talk about everything you'll think of wishing to hear about—his two years' work on the famous rockets "Tiny Tim" and "Holy Moses," also the revelations of the electron microscope at 60,000 diameters on unused and used particles of polishing abrasive.

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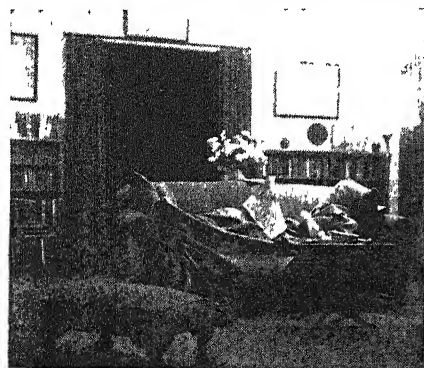


Figure 1: Russell W. Porter making flats by the proxy method. "I start my polishing machine in the basement," he says, "then I do this"

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that is, that polishing was the same as grinding, except on a finer scale. A paper delivered by Dr. Lloyd Motz of Columbia University and The Optical and Film Supply Company, New York, published in the *Journal of the Optical Society of America*, Volume 32, pages 147-148, further bears out the validity of the molecular flow theory. This theory is sometimes called the "butter" theory and at one time was looked at as perhaps a bit wild. The following is quoted from the paper mentioned above

"Rayleigh was one of the first to show by means of the microscope that polishing a surface is a process different from that of even the finest grinding; he concluded from his microscopic studies that polishing is a molecular phenomenon caused by the adhesive forces between the molecules of the polishing agent and those of the surface. Beilby added further to this idea by demonstrating that the polished layer resembles a film of viscous liquid and appears amorphous (in the case of polished crystalline solids) to the highest powers of the microscope. An examination of a polished surface with a microscope shows that the pits and scratches of the previous grinding are not eliminated by a wearing down of the surrounding surface but rather that these scratches are filled in by a flow of the surrounding material.

"Where one is dealing with a crystalline solid, the study of the polishing process is made easy by the fact that the polishing destroys the crystalline nature of the surface and builds up an amorphous layer. One can investigate the thickness of this layer for crystalline substances by dissolving the layer in a suitable acid until the underlying crystalline structure is reached. Thus in the case of calcite N. K. Adams reports that the completely amorphous layer was roughly 50 angstroms thick and that the flow lines produced by the fibers of the moving wash-leather were found at depths of 250-500 angstroms and some traces of the original ground surface down to 5000-10,000 angstroms.

"In the case of amorphous substances such as glass the investigation of the depth of the polished surface is difficult since there is no underlying crystalline structure upon which the polished surface rests. That the polished surface is, however, different in structure from the underlying glass can be easily demonstrated by subjecting the polished surface to the action of dilute hydrofluoric acid.

"If the polished surface is placed in dilute hydrofluoric acid for a short time, the high polish is not in general destroyed, but the surface becomes covered with innumerable scratches and pits of varying length and depth. Although many of these scratches exhibit a curvature which might be ascribed to the circular motion of the fine grinding machine, the evidence that these scratches are those originally produced in the glass by the fine or rough grinding before the polishing began is not conclusive. Another explanation which might be offered to account for these scratches is that, as

the polished surface is etched off by the acid, the rearrangement of the molecules in the newly formed surface gives rise to stresses which cause the surface to crack

"Although we may not conclude that all the scratches which appear after the acid treatment were present before the surface was polished, the following simple experiment demonstrates that scratches which are present on the surface before the surface is polished will reappear after polishing if the surface is treated with hydrofluoric acid

"On a highly polished glass surface (hard crown glass) several faint scratches of definite shape (letters and geometrical patterns) were traced by means of a steel razor edge. The surface was then placed on the polishing machine and rouge-polished until no trace of the original scratches could be discerned even under a microscope. The surface was then placed for a few minutes in a very dilute solution of hydrofluoric acid and then carefully examined. All the marks scratched on the surface by the razor edge reappeared in a more pronounced form than they originally had.

"It is clear from this result that the process of polishing is a molecular one; the forces of adhesion between the molecules of the polishing agent and those of the glass cause the glass surface to flow and fill up the cracks, pits, and scratches. This filling up process, however, does not obliterate the scratches in the sense that no distinction exists between the polished layer and the underlying surface. The action of the acid seems to indicate that the glass which has flowed into any surface deformities as a result of the polishing is more loosely bound to the surface than the surrounding glass and is therefore more easily removed by the acid.

"These results are of some importance in considering the degeneration which polished surfaces may suffer if not sufficiently protected over long periods of time. However highly polished and free of defects a surface may appear, it will, if not well protected from acid influence, develop scratches after a sufficiently long period of time"

HOGGING out a deep curve ("soup bowl") for a Schmidt primary is an endless job if done in the orthodox way. In *The Observer*, periodical published by the Franklin Institute, Philadelphia, Web Phillips describes a short cut:

"The tool is placed on the spindle and rotated at medium speed while the mirror is held in the hands against the edge of the tool at an angle of about 30° to the horizontal. Wet abrasive is deposited on the mirror with a brush and the mirror is rotated slowly in the hands as it is held against the tool. The action is slow at first until the sharp edge of the tool is ground off, then it becomes increasingly rapid.

"Eventually the curve on both the mirror and the tool will cover sufficient area to permit curvature control by length of stroke and from this point on the mirror is ground by conventional methods."

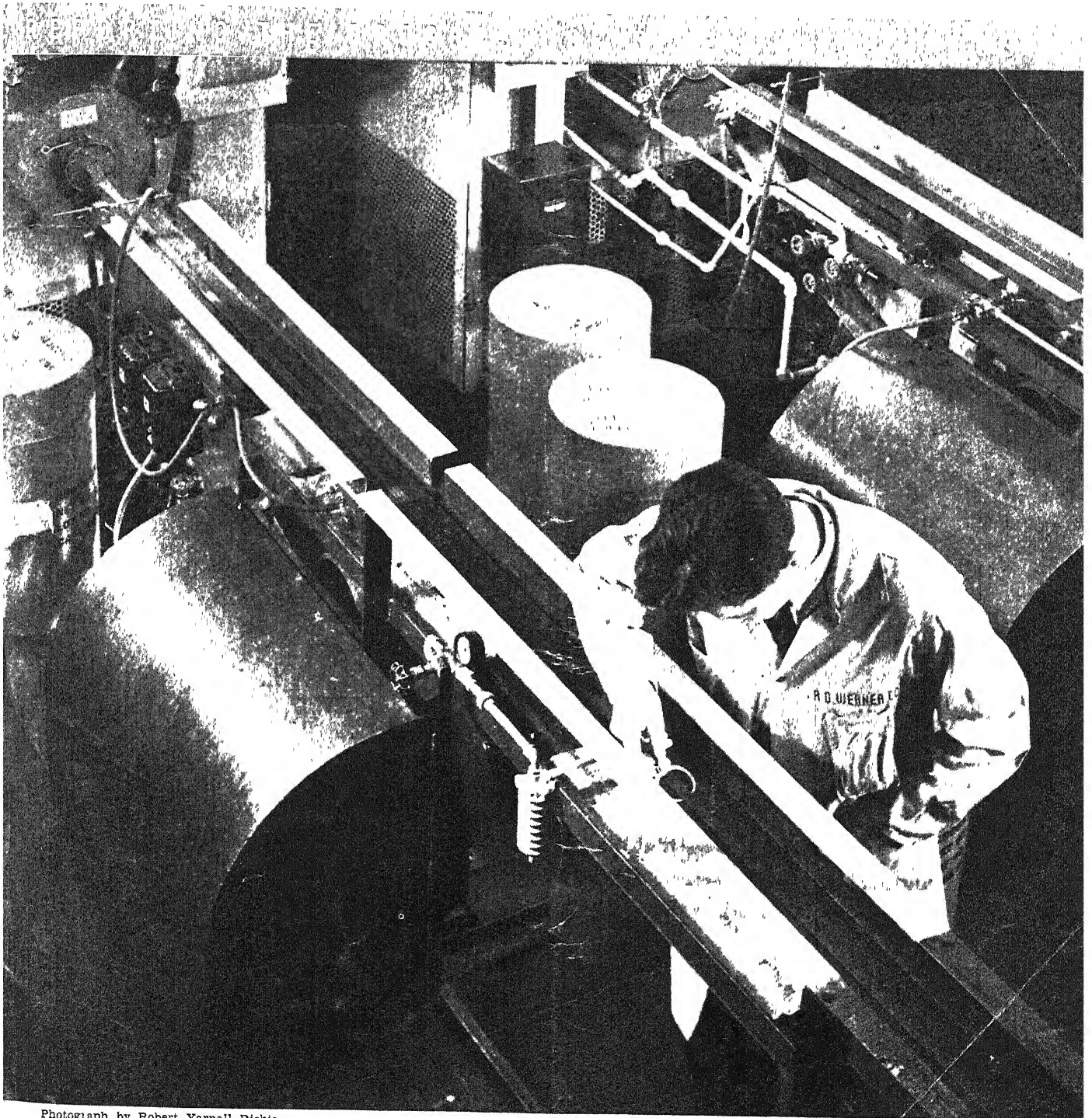
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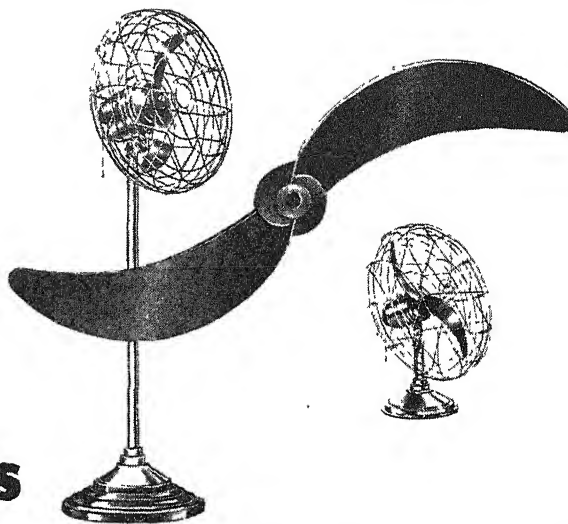


Photograph by Robert Yarnall Richie

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"CLEARING THE AIR" ABOUT PHENOLIC PLASTICS



The use of plastics by industry is increasing daily on a scope that is practically universal. Nevertheless, there still exists much confusion about the different types of plastics their properties and their uses. The purpose of this message is to help "clear the air" about phenolics—the most versatile of all plastics—the type of plastics which Durez has specialized in producing for the past twenty-six years.

The custom molded Durez propeller illustrated is the first plastic propeller that has been developed for such use . . . marks a new step forward for the plastics industry. In varying sizes, it is used by the Fresh'nd-Aire Company in several of their most popular Fresh'nd-Aire Circulators.

Why Plastics?

Moldability—a common denominator

of all plastics—naturally makes them highly desirable for producing an item of this sort—provided, of course, several other necessary properties exist.

Why Phenolic Plastics?

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The only plastic material which would provide this property and meet other requirements such as impact strength, heat resistance, tensile strength, and low-cost production, was a phenolic.

Why Durez Phenolic Plastics?

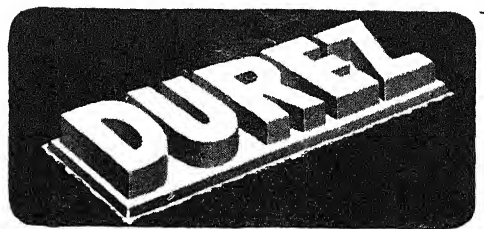
As specialists in the production of

phenolic plastics, Durez offers more than 300 versatile phenolic molding compounds—each scientifically developed for a specific purpose—from which to select the plastic that precisely fits the job.

Furthermore, Durez laboratory technicians possess a rich background of successful product development experience which makes their services invaluable in solving any unusual plastic material problem.

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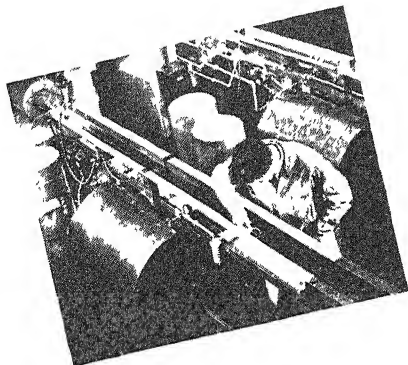
PHENOLIC
RESINS

MOLDING COMPOUNDS

INDUSTRIAL RESINS

OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB



INDUSTRIAL DRAMA—Plastics strip, widely used as edging and trim, is extruded from the machine shown in the upper left corner of our front cover. The continuous strip then passes under the watchful eye of an inspector who checks it to eliminate deviations in width. Photograph courtesy Hercules Powder Company

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50 Years Ago in . . .



(Condensed from Issues of July, 1896)

FIFTY YEARS of publication of *Scientific American* were editorially observed in the July 25, 1896, issue. The following comment is abstracted from that issue: "The material world has advanced so rapidly during the last half century, and with a pace so accelerated, that mankind has almost lost one of its most important faculties, and one essential to happiness—that of surprise. The *admirari* faculty is attaining a wide spread. The most marvelous developments are taken as a matter of course—the condition of things fifty years ago is seldom pictured to the mind—and all the material blessings which we now enjoy are used as conveniences of daily life, and no more."

CYCLE TESTING—"The American bicyclist has become a most exacting judge of the qualities of a wheel. He insists on perfect finish, silent running, and lightness. To meet this condition of things, the Pope Manufacturing Company, the makers of the world-famous 'Columbia,' have established a system absolutely unique in the bicycle world; namely a testing department, where every article which enters into the construction of a bicycle can be tested with the highest degree of accuracy. Samples of the tubing are subjected to direct and vibratory strains to see if it possesses the desired mechanical qualities. Steel balls are broken to test what they will stand, cranks, sprockets and chains are experimented with to ascertain the best shape and material for each. Spoke wire is fractured and its data are fixed."

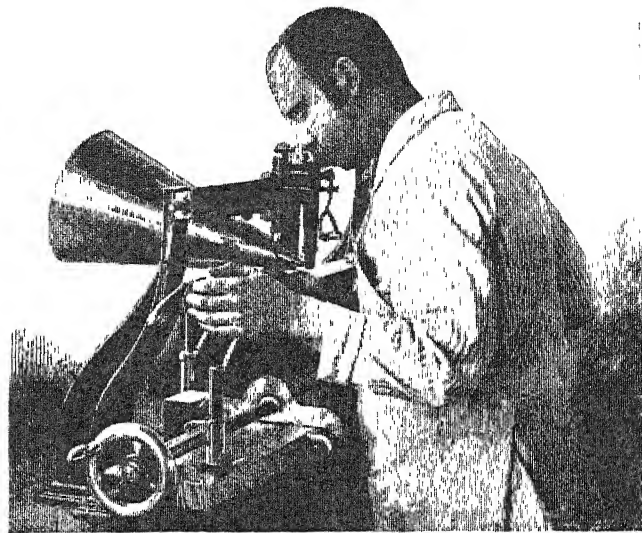
LUMINOUS PIGMENT—"M. Henry is a French savant of the school of higher studies, who has revealed the power of sulphate of zinc to absorb sunlight and give it back in the dark. The luminous pigment is not liable to be spoiled by damp, by carboic acid or by any weak acid."

TEMPERATURE INCREASE—"The question of the rate of increase in temperature from the surface of the earth downward has long been one on which prominent authorities differ. Among the scientists who have recently given this subject considerable thought is M. Joseph Libert, who records observations made at Produits colliery, Fleny, Belgium. These observations have been carried to a depth of 3,772 feet. Taking 82 feet as the depth at which atmospheric variations of temperature cease to have any influence, it was calculated that the rate of increase of temperature given by the tests at Fleny was 1° Fah for 53.97 feet of vertical depth."

BUILDING—"With the development of the art of steel construction, and the increase in the number and complexity of the problems which it involved, the line of demarkation between the engineer and architect began to grow more distinct, until today it is common practice for the architect to call in the aid of the engineer to design the structural steel work which gives stability to his buildings."

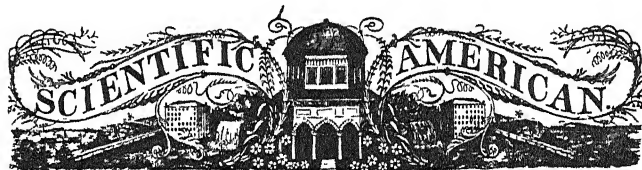
KNOT TYING—"Two of the most interesting automata now working within the limits of the United States are those used by the government for counting and tying postal cards into small bundles. These machines were made in Connecticut, and the two are capable of counting 500,000 cards in ten hours and wrapping and tying the same in packages of twenty-five each."

ACCURATE MEASUREMENTS—"Accurate readings from a micrometer caliper can be made to 1/10000 of an inch; from this one is able to judge with what care the parts of such an instrument must be made. The final testing of a



caliper of the kind mentioned must be made with the most delicate instruments, or with standards made to exact size. The accompanying cut shows the measuring machine, one of the numerous appliances for securing great accuracy peculiar to the shops of the Brown & Sharpe Manufacturing Company, of Providence, R. I., and used for the measuring of standard gages, and other tools that must be finished to exact size. Above the scale is a microscope, fitted with a micrometer eyepiece, for reading the graduations. The microscope is mounted upon a slide parallel with the scale. The micrometer graduations are read by means of a vernier scale, making the value of the graduations equal 0.00001 of an inch. The cone shown at the back of the machine is for the purpose of concentrating the light upon the graduations of the scale."

100 Years Ago in . . .



(Condensed from Issues of July, 1846)

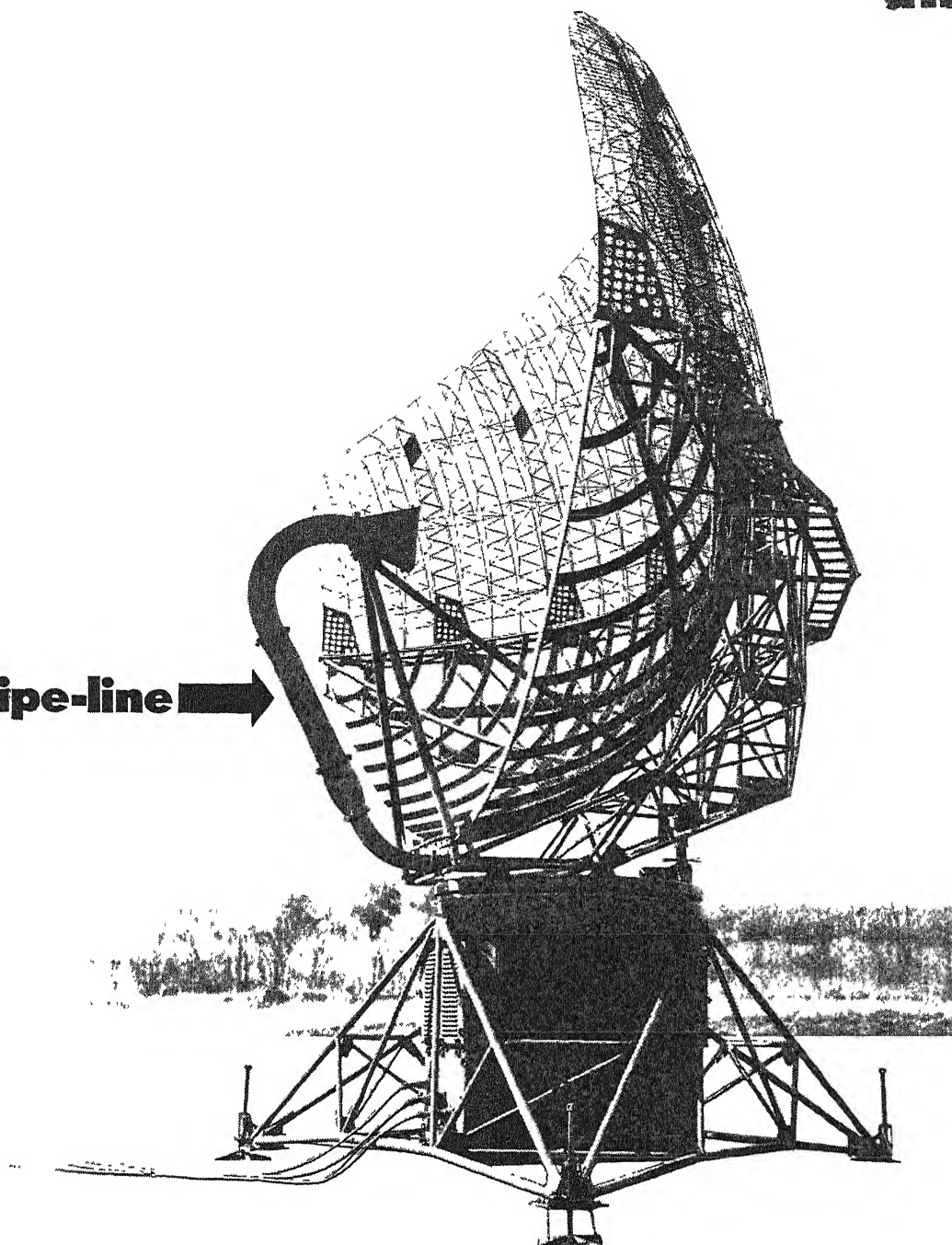
PRESERVED MEAT—"An English paper says that a case of preserved meat, taken from the wreck of the *Fury* which was lost in the Frozen Ocean in Captain Parry's first voyage, about twenty years since, it was opened by a gentleman at Brentwood, when it was found to be as fresh as on the day it was packed, and when cooked it was excellent."

ELECTRIC CLOCKS—"One of the latest exhibitions of the power of the electric fluid directed by human skill, is now manifested in regulating, setting, and running of clocks at any great distance from each other. A clock has been so arranged, by its connection with the wires, that the oscillations of its pendulum mark the hours on dial plates in two widely separated cities, at one and the same moment."

TELEGRAPH PROGRESS—"There are now in operation in the United States, about 960 miles of telegraph lines, and there will be 500 miles more added, according to present prospects, by the 25th of August."

NAVY—"England seems bent on outdoing the world in the way of a navy. She has now building 100 ships of war, among which are no fewer than 35 steam frigates and other war steamers; four 36-gun frigates; ten 50-gun frigates; and ten ships of the line, averaging from 80 to 84 guns each."

electrical pipe-line →



Microwaves make their journey from apparatus to antenna not by wire, cable, or coaxial — but by *waveguide*.

Long before the war, Bell Laboratories by theory and experiment had proved that a metal tube could serve as a pipe-line for the transmission of electric waves, even over great distances.

War came, and with it the sudden need for a conveyor of the powerful microwave pulses of radar. The metal waveguide was the answer. Simple,

rugged, containing no insulation, it would operate unchanged in heat or cold. In the radar shown above, which kept track of enemy and friendly planes, a waveguide conveyed microwave pulses between reflector and the radar apparatus in the pedestal. Bell Laboratories' engineers freely shared their waveguide discoveries with war industry.

Now, by the use of special shapes and strategic angles, by putting rods

across the inside and varying the diameter, waveguides can be made to separate waves of different lengths. They can slow up waves, hurry them along, reflect them, or send them into space and funnel them back. Bell Laboratories are now developing waveguides to conduct microwave energy in new radio relay systems, capable of carrying hundreds of telephone conversations simultaneously with television and music programs.

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE



BELL TELEPHONE LABORATORIES

Previews of the Industrial Horizon

SCIENTISTS VERSUS POLITICIANS

By A. P. Peck

WHAT makes a politician? What makes a scientist? Answer to the first question tempts a parody on the childhood formula involving puppy-dog tails; answer to the second brings in the inquiring mind plus academic education plus a certain detachment of self from the problem in hand.

It is encouraging, then, to both science and industry, that scientists, *per se*, are rapidly gaining recognition in the field of politics. To that field they bring a fresh viewpoint, largely divorced from most of the mundane considerations of politics as it has grown to be accepted. Stemming from the six geographical unions of atomic scientists, the Federation of American Scientists is indeed a step in the right direction. Here is a new political (perhaps quotes should be used here) force to be reckoned with. The Federation, composed of social scientists with a genuine realization of their obligations to the world at large, should be an ideal body to attack such problems as unemployment, fair wages, housing, labor relations, and the like. To such studies they would apply a detached point of view completely refreshing in contrast to the usual political selfishness.

The public at large, and industry in particular, should give its whole-hearted support to the Federation. From such a group can come such benefits as have never before emerged from any political organization.

FIRE!

FOR MORE generations than seem possible, in light of the seriousness of the problem, the matter of fire-proof buildings has been kicked around by building codes that refuse to take a realistic view of the situation. For example, many cities will permit unprotected wood-joint interior construction in gasoline service stations, but will not sanction steel, concrete, and other non-combustible materials unless they are fire-protected! Such building codes stultify the progress of new and improved materials. The sooner industry puts on the pressure to have them modernized, the sooner will tremendous fire losses decrease.

BOUNCING SYNTHETIC

LAATEST news from the synthetic-rubber industry concerns a material made from isoprene which exhibits more bounce and stretches farther than any other synthetic rubber now on the market. Reports have it that this latest elastomer is available in experimental amounts for those who would investigate its possibilities.

At the same time comes a statement from Goodrich that GR-S can now be produced at a "plant cost" of about 12 cents a pound or an all-in-all price—including overhead and return on invested capital—of 15 to 17 cents a pound. Here is the beginning of an answer to the synthetic-versus-natural rubber question. The price is down. The quality is up. The United States can produce economically the rubber that it needs. As a simple insurance policy—regardless of isolationist or non-isolationist tendencies—our synthetic rubber productive capacity must be maintained. To abandon it now, as a sop to international policies, would be the worst kind of technological suicide.

PREFABS

DEMAND for prefabricated houses is zooming, regardless of anything that the public may have to say concerning the undesirability of some types of homes built on mass-production principles. Yet, despite this demand, the prefab indus-

try is impotent to fill the bill. Shortage of materials is the answer.

A recent survey showed that the prefabricated-house industry was geared to produce 150,000 home units a year. But reconversion has been slow. As of now, it appears that if 50,000 units are built during 1946, the industry will be doing very well under existing circumstances.

Designs for prefabs range all the way from conventional practice to weird hemispherical structures of aluminum alloy and steel with a central steel mast, the whole unit built on suspension-bridge principles. Some are so radical in appearance that there is a serious question as to whether or not the public will accept them. But, no matter what the design, the problem of materials still haunts. Until shortages are relieved, and home builders can perfect their plans in all aspects, prefabs as well as conventional hand-built homes will suffer delays.

Without being too optimistic, it is safe to say that the prefabricators with sound bases—such as Gunnison, Precision-Built, Hodgson, Shelter Industries, and so on—will come out on top. The principles of prefabrication are well established; the trend is away from the all-alike-in-a-row style of building; prefabs can fill a definite need in the nation's critical housing shortage, but they will not get their chance until materials are available to them as well as to conventional building proponents. Then the battle for markets will really start. Our money goes on those prefab builders who take into consideration the fact that most people want a home which not only gives them the fundamentals of shelter and comfort but also permits them to express their own tastes.

OIL FOR THE LAMPS OF INDUSTRY

COTTONSEED oil, basic to a number of industries ranging from food to chemical processing and surface coatings, is receiving intensive study in a number of laboratories. Improved methods of extracting the oil have been developed. Pressure extraction and solvent extraction both hold promise of increasing the amount of oil obtained from a given quantity of cottonseed. Results to date show higher yields per ton of seed, with decreases in cost of operation.

FOR FUTURE REFERENCE

STRUCTURAL panels made with a new reinforced Du Pont resin are being tested for such diverse applications as tooling jigs, automobile bodies, airplane fuselages, kitchen sinks, and refrigerators. Unwoven cloth, that eliminates the need for looms, is being made by a "felting" process using cotton fibers bound together with plastics, result is a fabric that, while exhibiting only unidirectional strength, has already found uses in shoe linings, draperies, handbags, and diapers; although the new cloth is porous, it has not yet reached a point where it can be used for shirts or dresses. . . If the radio industry—when it gets into full swing—hopes to recapture its markets, designers of radio receivers must take into consideration mechanical performance, appearance, and functional convenience, if the industry ignores these primary factors, established firms will lose business to new-comers who have business sense enough to heed public demands. . . Industrial accidents have taken a big jump since V-J day; accident prevention is sound business that should not be neglected under any circumstances. . . Small or isolated wheat-producing areas can benefit by a new portable flour-mill which can be operated right in the field, being towed to the operating site by a tractor or a Jeep.

Processes Must Mature

To Evaluate Properly All the New Processes that Appear, Industrial Management Would Need a Crystal Ball. Next Best are Standardized Tests—Often Unestablished—and Long Experience, which Demand Time. Hence, Most Developments Need a Long Maturing Period

By EDWIN LAIRD CADY

ABOUT four years ago, scientists in the Portland cement industry announced that if concrete-reinforcing steel shapes were put under heavy tension and held that way while the concrete was poured and allowed to set around them, then the final strength of the concrete could be increased in almost direct proportion to the tension on the reinforcement.

Working along similar lines, steel engineers were finding that if steel were pre-stressed either by shot

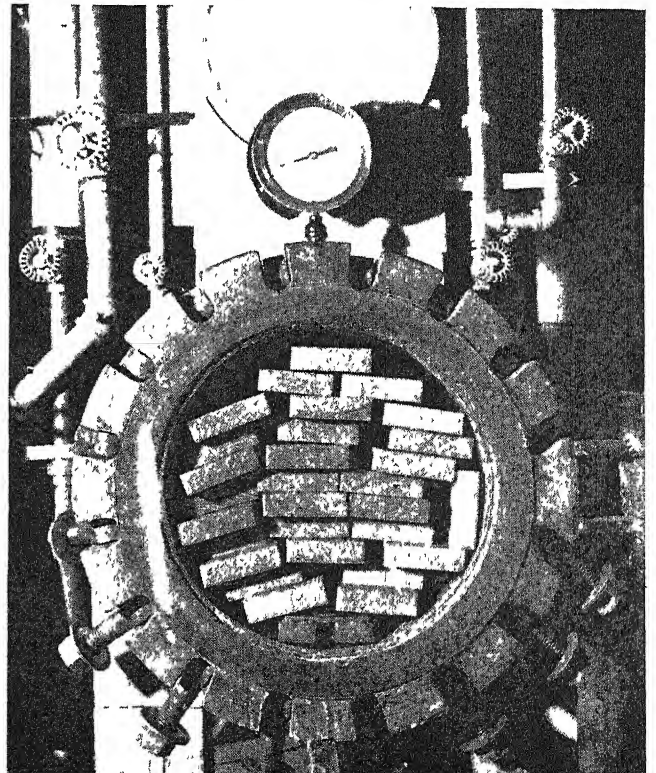
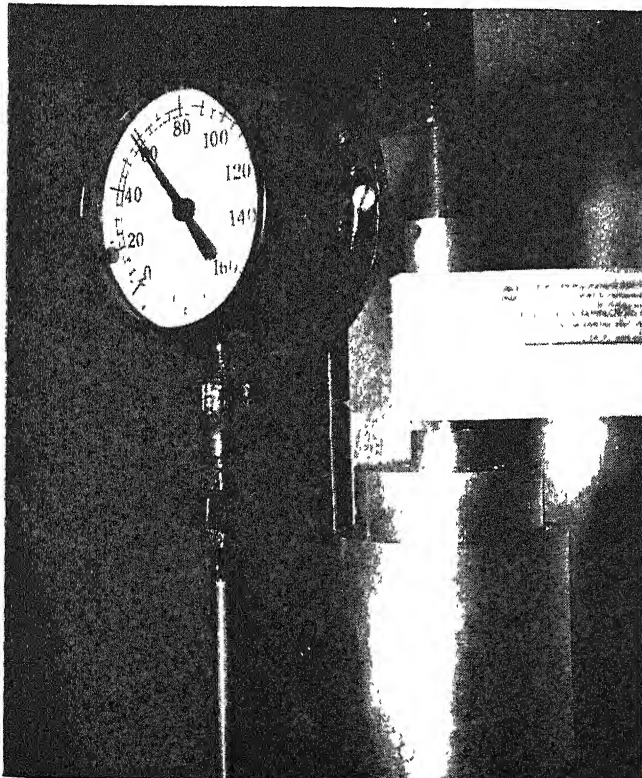
peening its surfaces or by rolling to special indented patterns, then for the same service the weights of parts made from it could be reduced anywhere from 25 to 50 percent.

Each of these new techniques promised to give engineers something they long had wanted; greater strength with less weight and space. Yet, no more than a baker's dozen of plants in the entire United States are equipped to do a real job of concrete reinforcement pre-stress-

ing for more than a limited number of special products such as tanks. And, aside from the few large makers of automobiles and airplanes and agricultural machinery, there probably are not 50 factories operating shot-peening machines for the sole purpose of strengthening steel parts.

The slowness of this progress is not to be blamed upon any lack of knowledge or of appreciation of the merits of these processes by the engineers who might use them. The processes simply are too young to have gone very far.

Industrial processes and products grow much like human beings. They



DMU-treated wood is in process of "growing up." In test set-up (left), pin is buried in untreated upper slab, but only dents treated lower board. Kiln (right) typifies problems common to new industrial processes. Here, automatic controls must supplant manual systems

• LOOKING AHEAD •

Many spectacular war-born products and processes won't find immediate homes. . . Some, however, will emerge several years from now as standard industrial items. . . Others will come to rest on the scrap heap. . . A few, certainly, will eventually be "discovered" as boons to supposedly remote businesses. . . Efforts to apply new ideas may meet less resistance than in the past . . . Cost-saving processes now particularly welcome.

emerge as infants, interesting but weak and in need of careful nurturing. They go into adolescence, into strong and aggressive youth, balanced and steady middle age, seasoned but fading senility. And one of the hardest problems of industrial management is to know just what "age" any one process should be allowed to reach before it is taken on.

Such decisions can be based upon both emotional and practical grounds. Individual executives or whole managements can be youthful-minded, and prefer the new developments; "middle of the road," and strong for the middle-aged processes; conservative, and sticklers for the traditional. But besides acting the way they like to act they will usually do whatever will become the most profitable.

TREATED WOOD—Dimethylolurea—DMU, for short—treated wood is an example of what is likely to happen to any brand-new process. Its

story is much like that of the prestressed concrete reinforcement, the shot-peened steel, and many others.

DMU was announced about four years ago by Du Pont, who make the chemicals for it. It got the wide publicity which usually is received by anything unusual. But aside from the news stories nothing much happened.

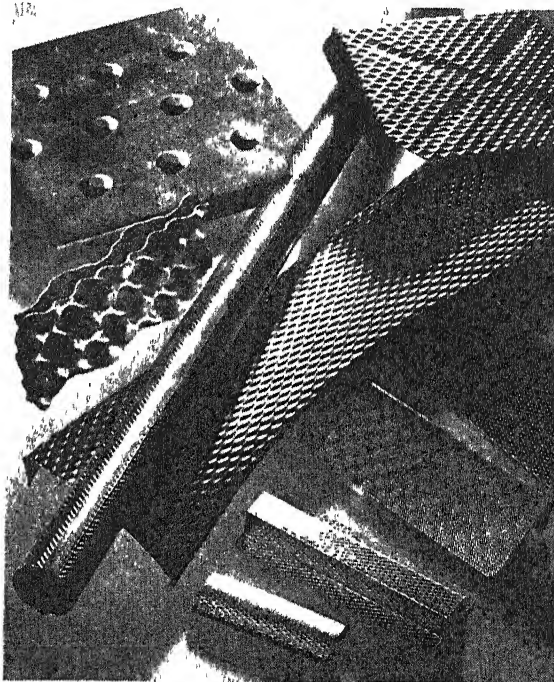
Then S S Keeley and Sons decided to pick the infant up and see what could be done with it. The Keeley company was old but its management was young, hard hitting, open to the possibilities of a fresh, new product.

Known facts were that the process would make woods much harder—

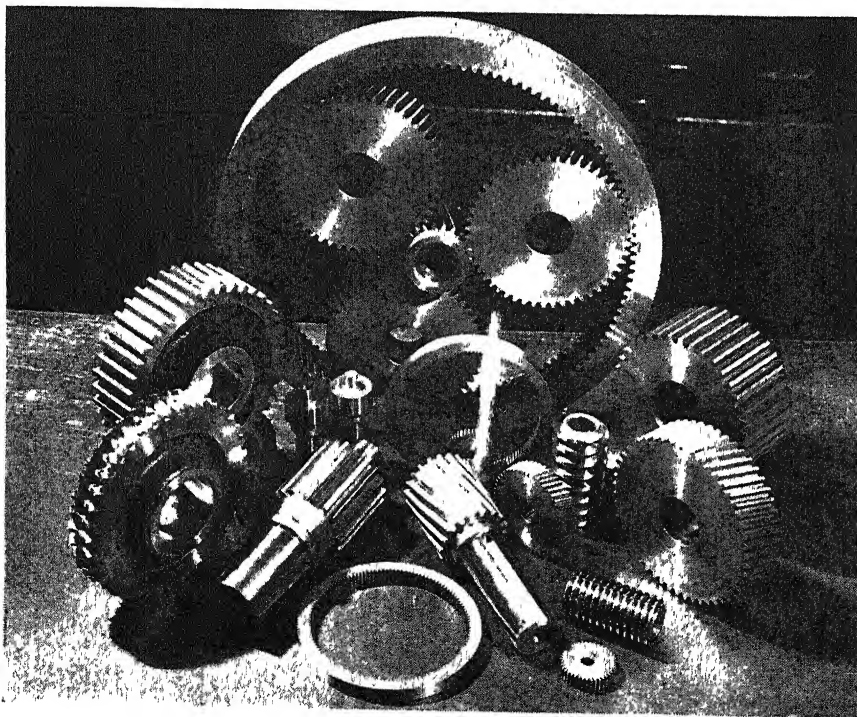
pine being made as hard as untreated maple, and maple much harder than in its untreated state; that the transverse strength of the wood would be increased to the point where splitting was as difficult as breaking by tensile pull; and that the dielectric characteristics and the resistance to chemicals would be greatly increased. There also would be process difficulties—two kiln dryings instead of one, and careful control of vacuum, heat, and pressure being mandatory.

The second kiln drying had to be done after the wood had been impregnated with the DMU, and it presented unusual problems. Ordinary operation permits men to enter

Rigidized metal (right) suggests a variety of useful applications. Wide-spread and universal acceptance, however, will probably require time. Gears (below) exemplify a time-proven and fully matured product.



Courtesy Rigid-Tex Corporation



the kiln, see just how the drying is progressing, and change the temperature and the humidity to get the quickest results while avoiding damage to the product. But the DMU-impregnated wood gives off dangerous gases and men cannot enter the kiln after the process is well under way. Experience, plus the records of instruments and the use of automatic controls far more accurate than those commonly used with kilns, had to be substituted for personal inspection of the work.

TEST PROBLEMS — Experiments with various species of woods had to be made, are still being made. Not more than one fourth of the kinds of wood in common commercial use proved themselves to be fully suited to this process. Some of the others proved to be partially acceptable, others wholly unsuited. The results with various species were not uniform. Pine became as

hard as maple but it did not become maple, it became a brand new industrial material with pine as its main ingredient

As is all too common with new materials and processes, means for testing the finished product were lacking. The hardness of one wood could be compared to that of another but not very directly with that of plastics or metals.

An old-line maker of textile machinery had problems severe enough and management youthful-minded enough to try the DMU-treated woods. It was found that these woods would not "hair-up" or raise the grain at the surface of the finished parts, and thus these parts could be kept in service much longer than those of untreated woods. The haired-up grain, formerly experienced, caught the yarns that passed over the parts and damaged them. But there were no mechanical or other practical tests for hairing-up of wood surfaces, the superiority of DMU in this respect had to be established by experience and the experience took time.

In the meantime, other users were experimenting with the resistance to splitting of the product, were finding that they could eliminate the metal reinforcements which they had applied to untreated woods. One had a product in which the wood had to hold metal parts which were driven in like nails. There was no other test of this holding ability than to drive the parts in and pull them out again and keep on doing it until the DMU superiority for this purpose was established.

TIME NECESSARY — The Keeley company also was finding out more about their product. For example, ordinary wood-working methods could give it such a fine finish that sanding often could be eliminated. A wood-working planer of the kind that uses high-speed knives and takes many cuts per inch actually can put a mirror finish on DMU-treated wood. Small holes can be drilled more accurately in it since the drill does not turn and follow the grain.

Every bit of this new knowledge made new markets possible for the product. But those markets had to be found among customers who had youthful-minded executives willing to try something new, or else had problems so severe that they would try anything once.

Now there are at least 20 companies doing DMU processing in the United States. Keeley is greatly increasing its facilities and with markets in plain sight for all its output.



Hand-scraped bearings still hold their own on many important jobs in industry since their characteristics have been proved through long and successful use

But, even so, this product does not enjoy one customer for every thousand it probably will have when it reaches middle age.

Between the inception of DMU, or any other new product, and its fully matured markets is a long period of finding out what qualities to test for and how to test for them, of getting customers used to buying it and habituated to its fabrication methods; of finding out where it does not fit, as well as where it does.

INDUCTION HEATING—A fair example of a process which is just getting well into young manhood is induction heating.

In spite of the fact that induction heating dates from about 1922, has been used for the melting of metals since the early 1920s, and for hardening and soldering for well over ten years, there probably are not more than 3000 companies having induction heating equipment in the United States.

Probably 50,000 factories could use this process with profit. It can save as much as \$5.00 per unit on

the hardening costs of a single complex part, can permit the substitution of low-cost, easily-machineable carbon steels for high-cost and hard-to-machine alloy steels, can solve a multitude of brazing and soft-soldering problems. But induction heating has progressed very slowly from precision melting of small lots of alloys to the hardening of the bearings surfaces of crank shafts, to the heating of steel for forging, the hardening of gear teeth and other contoured parts, and finally to all sorts of hardening and soldering operations.

In the beginning, nearly every installation was tailor-made for a single operation or a known combination of operations. The user who wanted to convert his equipment from one operation to another commonly had to send for the service engineers of the equipment maker to plan the new job and even to change parts of the equipment itself. To a large extent this still is so. But as the varieties of parts handled by induction heating have grown from tens to thousands, and

then to hundreds of thousands, more and more engineers have learned how to handle induction heating and what may be expected of it. Single installations costing more than \$500,000 are being made. Flexibility and adaptability are on the increase. Induction heating has gotten past the risk and the experiment stages which attend a completely young industry, but it still is so young and lusty that it is making even faster progress now than during the war.

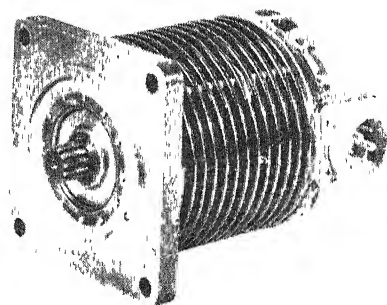
OLDER PRODUCTS—Gears are an excellent example of a middle-aged industry. They keep on improving, of course, but not too radically. A new hardening process like induction heating or like modern carefully controlled flame hardening; a new machine with electronic or other improved controls; a new production method like powder metallurgy or precision investment casting; a new alloy or new plastics material; any such improvement means that some part of the gear industry takes a long step forward. But gears are well established, well understood, universally accepted.

Very seldom is there any large profit margin in making them, or any risk in adopting them. They are a safe, sane, middle-of-the-road means for the transmission of power,

in most cases as free from drama as from gambles when any engineer designs them into his products.

Hand-scraped bearings are a very old institution. At one time, there was no substitute for them when a shaft had to be held in strict alignment. Now, there are anti-friction bearings and many other kinds which have passed through their youthful stages and become well established. And yet, on many large motors and other important jobs the hand-scraped bearings are preferred. Every weakness as well as every good point about them is fully known and understood. In common with nearly all of the "old" products which persist in industry, this completeness of understanding of them, this perfect knowledge of what they will do and how they will do it, makes them highly profitable for some uses.

The progress of any product or process from extreme youth to old age is one of swapping high profitability, plus somewhat unknown and uncontrolled risks, for lower unit profitability but with risks more controlled or eliminated. But it is the use of well-established, risk-free products which enables a management to take the gambles and gain the profits with the younger and less developed ones.



Four-horsepower, one-minute motor

is largely determined by its temperature rise under load, and this in turn depends upon how long the load endures. If the motor is to run for less than one minute, and then is to rest, it can have very high capacity for its size and weight. For example, a four horsepower motor of this type may weigh only 7.2 pounds.

Industry has a large variety of such short-interval jobs for motors to do on pumps, instruments, regulators, and so on.

PLASTICS VALVE SEATS

*Match Rough Surfaces;
Extend Valve Life*

SMOOTHNESS, toughness, and the conforming qualities that make some artificial fibers suitable for ladies hose, make the plastics forms of those fibers highly useful in pump, faucet, and other valve seats. The new plastics seats will hold air pressures of over 2500 pounds per square inch when mating with surfaces which have not been hand lapped. One result of this may be to greatly prolong the lives and reduce the maintenance costs of high-pressure and of some low-pressure valves. The abilities of the plastics to conform to slight surface irregularities will permit valves to be kept in service which by previous practices would have been too badly worn or eroded on their mating faces to hold the pressures.

ADHESIVES FOR METAL

*Secure Multiple Pieces
For Production as Unit*

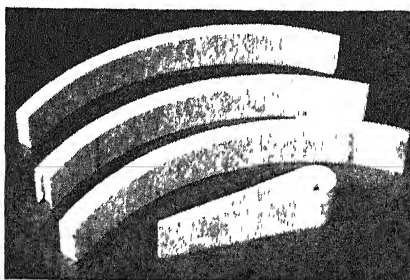
BY THE use of war-developed adhesives, aluminum parts can be fastened together with joints having shear strengths of over 5000 pounds per square inch. Engineers are just beginning to examine the possibilities of such simple and inexpensive fastening methods. One immediate use is to fasten or gang together several parts which are to be machined, riveted, or otherwise fabricated as single assemblies. The method eliminates many costly clamping and inspecting operations.

USEFUL WOOD

*Finds Ever-Wider Range
as New Processes Develop*

IN SPITE of the rapid development of metals, plastics, and other materials, wood still is the handiest material to fabricate with simple tools and machines.

Working hard to make wood more useful are such processes as chemical fire-proofing, followed by compression. The compressed wood loses only its air cells, retains all of its



Formed wood parts hold their shapes

strength and its workability, offers high strength with light weight and reduced volume.

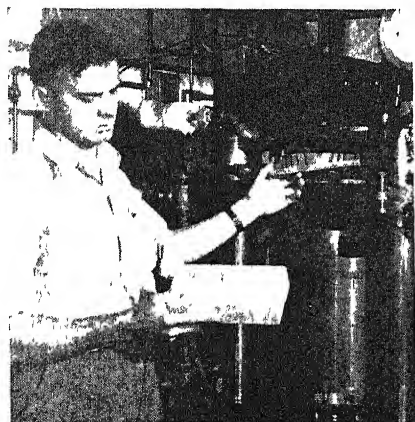
Light and soft woods can be laminated or faced with wear-resistant compressed woods or heavily compressed papers. Thus bulk with light weight, stiffness, and strength may be had. And these combinations can be formed to hold their shapes with high stability.

ONE-MINUTE MOTORS

*Give High Power for Size
in Short-Run Applications*

AMONG the surplus war items finding readiest sale to industry are the one-minute motors especially developed for aircraft use.

The capacity of an electric motor



Heat-stabilized wood, being taken from press, was originally same thickness as block in technician's hand

Industrial Hemstitcher

Closely Approaching a "Sewing" Machine for Metal, Resistance Welding has Multiple Advantages of Which High-Speed and Economy are Only Two. Spot Welds, Seam Welds, and Flash Welds are All Variants of the Resistance-Heat Theme. Keynotes are Versatility and Ease of Use

By FRED P. PETERS

Editor-in-Chief, *Materials & Methods*

INDUSTRY is hearing more and more about resistance welding today, and if developments now on the drawing boards mature, this form of fastening may eventually become as familiar as soldering and riveting. Resistance welding is basically the process of joining two pieces of metal by placing them in contact with each other, pressing them together, then heating locally to fusion by passing a heavy electrical current—A.C. or D.C.—directly through the joint. No extra metal or filler rod is added as in arc or gas welding, and the area of heating—and therefore of metallurgical changes—is sharply localized.

Resistance-welding machines are

in the "machine tool" class with respect to both initial cost and suitability to production-line operations. Indeed, metal-joining resistance welders have been the subject of as much development and improvement in recent years as have their metal-cutting machine tool counterparts. Resistance-welding equipment, according to the Resistance Welder Manufacturers Association, sold to the extent of about \$4,000,000 worth in 1939. By 1944, admittedly a peak-production war year, this figure had become \$30,000,000. And resistance welders, now manufactured by some 30 companies, are key production equipment in thousands of plants for making a vast

• LOOKING AHEAD •

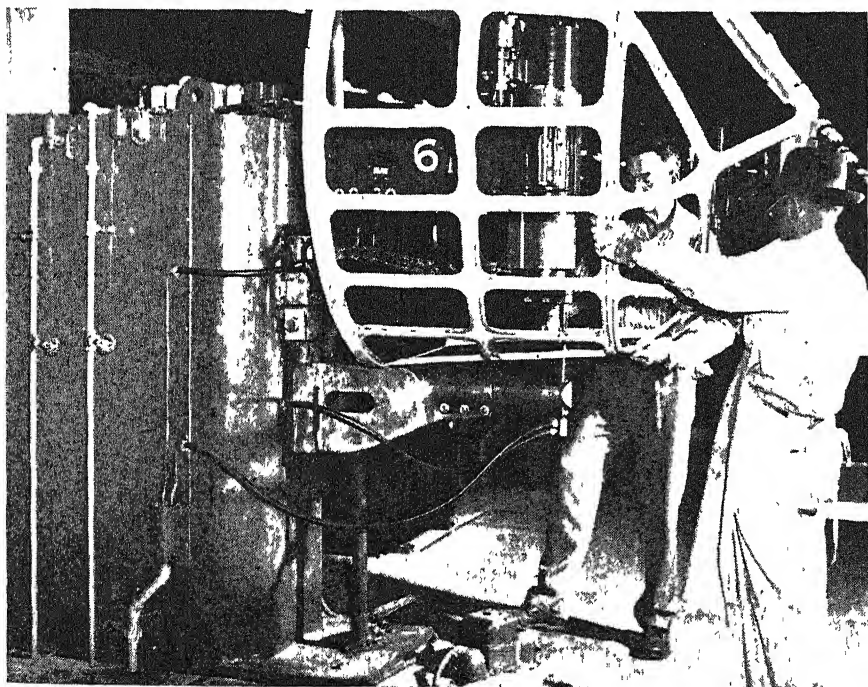
More resistance welded products as designers come to predicate production on this process. . . Changeover from general-purpose welders to specific-use units. . . Higher production of articles stymied by solder shortages. . . Replacement of skilled welders and brazers by welding-machine "operators". . . Substitution of welded multiple-part assemblies for intricate castings.

number of different products, ranging from aircraft fuselages and railway cars to tea-kettles and jewelry.

VARIED PROCESSES—The many possible adaptations of resistance welding have given rise to several distinct types of processes, including spot welding, seam welding, projection welding, upset-butt welding, and flash welding.

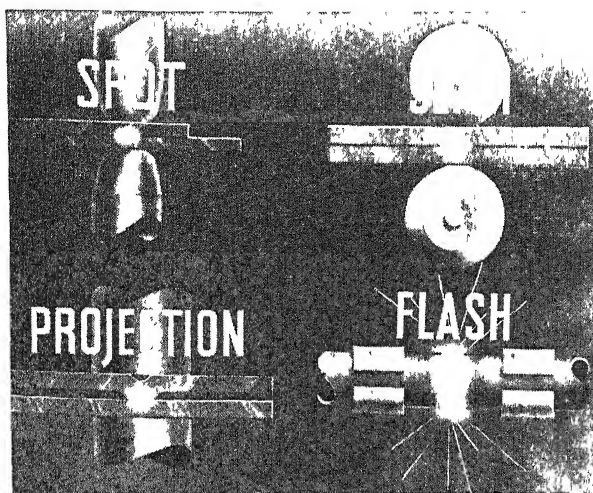
Spot welding, the most versatile of the resistance-welding processes, consists of clamping the mating pieces between the ends of two rod-like electrodes connected to a high-current, low-voltage transformer; electrode pressure and the heat generated by current passage produce a fused button or weld "nugget" joining the metals at the spot between the electrodes.

Seam welding employs rotating-wheel electrodes which roll along the joint, producing a continuous pressure-tight seam instead of a series of spot joints. Projection welding is a form of spot welding but has the added feature that tiny projections, previously stamped or



Courtesy Consolidated Aircraft Corporation

Light but awkward-to-fabricate structures are well suited for resistance welding



Resistance-welding technique has many facets from which stem wide adaptability. Here diagrammed are four of the more common ways of accomplishing metal fusion by this process.

Courtesy General Electric Company

machined on the work, serve to concentrate the current at the spot even though relatively large-diameter electrodes are used. In upset-butt welding, the ends of two pieces, each clamped in an electrode, are pressed together without overlap while current is passed through them. Flash butt welding—commonly called just “flash welding”—is similar to upset-butt welding except that the current is turned on as the pieces to be joined are moved toward each other; an intensely hot arc is formed, and when the metals reach the proper temperature they are forced together and the current is cut off.

Each process has a variety of subdivisions and equipment types. Thus, spot-welding machines include portable welding “guns” and pedestal types which may in turn be rocker-arm or press machines. Machines for projection welding closely resemble press-type spot welders—in fact, spot welders are often used as light-duty projection welders. Seam welders have their own operating features, including flexibility in the choice of current pulsation to produce either a tack-welded or a continuous weld (overlapping-spots) effect. Upset-butt and flash welders are still different in design.

Because the heat for resistance welding is generated by the resistance of the metals to the passage of current, very high currents are usually necessary; hence a high peak demand is made upon the power supply. To help reduce these peaks one of the most important of the recent improvements in resistance welding—the use of “stored energy” systems—was devised. Such systems, which employ transformers, capacitors, or storage batteries to store the supply-line current between welds, have been a boon to the welding of aluminum, which, because of its low resistance, requires unusually high current for successful welding.

Close control of heat, pressure, and time cycles is essential to successful welding. Modern electronic-control equipment has made resistance welding a simple, fool-proof, precision operation that lends itself ideally to automatic mass-production requirements, and has probably contributed more than any other factor to the rapid expansion in use of the process.

ADVANTAGES—All these factors and the resultant benefits to industry have recently been the subject of a searching survey by General Electric Company, from whose report many of the following examples have been taken.

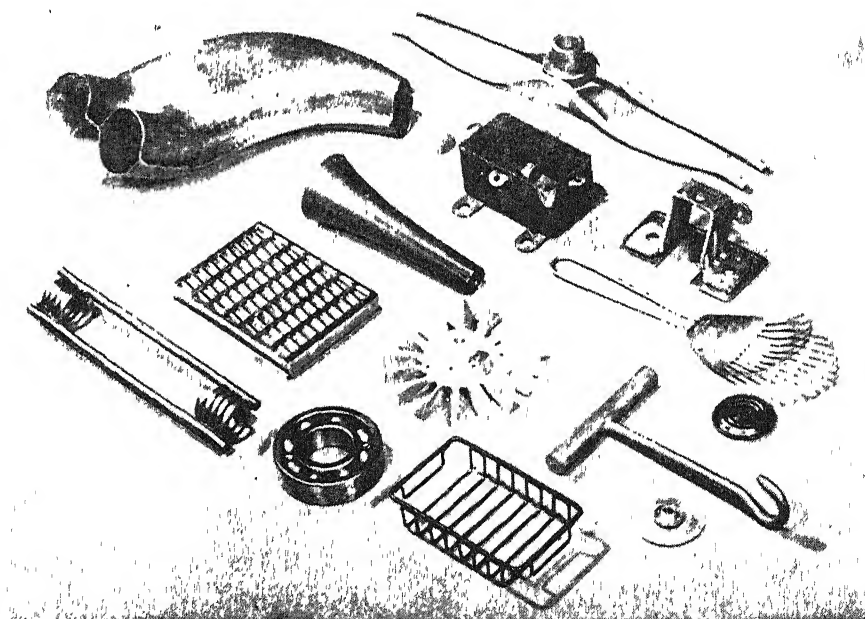
For the various applications to which it is readily adaptable, resistance welding has demonstrated several production-simplifying or cost-reducing advantages, alone or in combination. These include: faster welding, easier assembly and handling, minimum distortion, virtual freedom from undesirable met-

allurgical effects, lower skilled-help requirements, savings in material and so on. Most metals commonly welded in industry by any method, plus some that are extremely difficult to handle otherwise, can be resistance welded. Dissimilar metals, very thin sheets, thick-sections-to-thin-sections, tiny parts, and mammoth products are all easily handled.

On the tiny end of the scale, hard iridium nibs are resistance welded to gold-plated points for fountain pens, and wires half the thickness of a human hair are resistance welded for thermocouples, instruments, and electronic tube filaments and grids. At the other end of the scale lie such applications as resistance-welded railroad passenger cars, automobile X-frames, flash-welded steel auto-body sections, aircraft fuselages, and similar products.

An interesting use that has affected many fields is the resistance welding of sheet metal stampings to give intricately shaped parts which would normally have to be made as more expensive castings or forgings. Thinner sections of sheet metal can be used than are readily cast; also, the welded sheet metal is stronger than the very thin cast sections. Small sheet metal sections may be built up by multi-layer welding to make an exceptionally strong piece. The use of coined projections on stampings up to 1/2-inch thickness has made possible the replacement of many heavy castings with projection-welded parts.

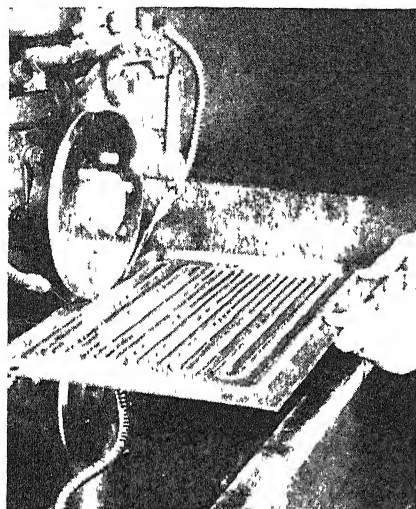
Resistance welders with slight modification can also be used for brazing and soldering. Thus, brazed contacts and windings give superior



Welded articles from several fields emphasize need for specialized welder units

electrical connections that will not open or melt during overloads. There are portable resistance-brazing machines that can braze the windings of electrical machines after the windings have been installed, and others are used to make connections in heavy bus-bar systems.

WIDE UTILITY—During the war the Army standardized on a five-gallon gasoline can, the body of which was drawn from sheet steel. The metal, drawn hard and thin by the forming



Refrigerator part was simplified and production speeded by seam welding

operations, made arc welding attachment of the handles difficult because of the ease with which the arc burned through. Spot welding was adopted and 80 percent of the time previously required was saved.

Again, spot welding of steel switchgear has been reported to be five times faster than arc welding, four times faster than bolting, more than six times faster than riveting. Resistance welding the studs on to the gear panels of switchgear eliminates seven operations formerly required—punching a hole in the panel, threading the hole, counter-sinking for the screw-head, inserting the screw, peen-locking the screw, grinding the peened surfaces smooth, and filling-in the rough surfaces.

Demonstrating the production-line utility of resistance welding is an installation in which a number of sheet-metal stampings were welded together to form an aircraft part. Eight portable spot welders were arranged inside a circular track about 20 feet in diameter, over which a conveyor moved in an endless circle. At the first station, the stampings are placed into fixtures, and the conveyor table moves on under each welding gun in turn, each with a specific operation to perform. At the final station, the

finished piece is removed from the fixture and the conveyor moves on to the first station again. About 10 fixtures, permanently mounted on the conveyor table, keep the entire group of guns in continuous operation.

Resistance-welded steel auxiliary fuel tanks for airplanes represent an example of weight-saving possibilities. The elimination of rivets, even for the swash plates inside, gave a light, strong, fluid-tight product. Resistance welding also gave a smooth finish that cut down the air resistance. The resistance-welded tanks were produced faster, better, and at an 83 percent reduction in cost.

Both uniformity of product and amenability to continuous processing are exemplified by a resistance-welded refrigerator evaporator. Two pre-formed flat halves are held in a jig and tack welded with a spot welder, the final seams being seam welded before the evaporator is bent to its final form. More than a million of these evaporators were made with rejects of less than $\frac{1}{2}$ of 1 percent.

ECONOMY—Savings, by resistance welding a complex assembly, were clearly shown in the manufacture of welded armored half-track sections during the war. These heavy pieces were formerly made by a combination of arc welding and riveting that was slow and required many skilled operations. After the job was redesigned for resistance welding, one company saved \$240,000 just in the cost of training the necessary personnel, in addition to other operating economies.

In still another case, a flash welder paid for itself in four months of use through the savings that it effected in fabricating stampings for automobile rear-axle housings. And in a railroad shop, large amounts of expensive seamless-steel tubing for locomotive boilers are saved by cutting off worn tube ends and resistance welding new pieces in place. The main sections of the tubing are used dozens of times before they need total replacement.

In the future, one authority believes a large percentage of the resistance-welding machines will be specially designed for individual jobs, the implication being that much present-day equipment will be made obsolete or must be re-fixtured. For example, five years ago refrigerator liners were manufactured at the rate of 35 per hour; today, newly and specially designed resistance welders produce these same parts at the rate of 100 per hour. Again, low-capacity welders

will be more widely used, especially in the costume-jewelry field where outmoded models are still fairly common.

Many steel companies are planning to aid the expansion of resistance welding by supplying a larger variety of cold-rolled strip designed for easy spot welding. In light metals, too, various extruded sections are available which can advance resistance welding further in the field of light, durable products.

Other important future uses for resistance welding are expected to be in the production of many building-components for mass fabrication of homes; in the large-scale production of metal boats less than 40 feet long, and in the manufacture and assembly of air-conditioning equipment—all this in addition to the substantial and still growing use of the process in the basic transportation-equipment industries: railway, automotive, and aircraft.

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COPPER-COATED

Aluminum Has Advantages For Electrical Uses

EXPERIMENTAL test runs are now being conducted on a new aluminum-base product designed to compete with brass for electric light sockets and other wiring devices. The new material is copper-coated aluminum and it has the special advantage of being easy to solder. Its conductivity, of course, is excellent and in addition it is said to have a price advantage over brass.

NON-AGING STEEL

Results from Use of Titanium in Alloy

TITANIUM alloy steels are coming along fast, especially the sheet steel recently developed for vitreous enameling. Non-aging and non-blistering when enameled without the customary ground-coat, titanium steel possesses excellent deep-drawing quality. All carbon in it is combined with titanium, the finished steel containing 4.5 times as much titanium as carbon. Its stress-strain curve is more like that of a non-ferrous alloy than low carbon steel. In an oil refinery, exposed to reducing gases at over 700 degrees, Fahrenheit, at high pressure, no appreciable change of properties was evidenced, while in the same application, plain carbon steel lost virtually all its ductility, and high chromium steel absorbed nitrogen excessively.

By-Product Bonuses

Petroleum By-Products, Like Ordinary People Working Without Great Fanfare, Receive Scant Attention Because There are so Many of Them. But They do Their Jobs Well, and the Background of Many By-Products Hold Bright Stories of Careers Salvaged from Oil-Refinery Wastes

By JOHN C. DEAN

Technical Division, Process Products
Socony-Vacuum Oil Company, Inc

GIVEN a problem in which it appears that some form of petroleum might be useful, it is a better-than-average bet that the process products technicians will come up with a much better-than-average answer. And frequently this answer will be a process product made from one of the so-called refinery by-products.

When a substance as complex as petroleum is subjected to the ex-

tensive refining and compounding sequences, it is inevitable that a large variety of by-products will appear. Equally inevitable is the probability that many of these by-products should prove extremely useful. But the very fact that so many of these valuable substances do exist, in addition to there being so many uses for them, makes any attempt at discussing them a difficult task. Necessarily, they must be grouped

• LOOKING AHEAD •

More by-products, rather than fewer, as petroleum chemistry expands and processes grow more complex. . . And for these materials, some with characteristics all their own, there will be jobs. . . Specialized jobs mostly, requiring research to match by-product and use. . . New textiles needing revised processing techniques. . . Stronger emphasis on preservation of organic materials. . . Better anti-rust and packing measures. . . All at least partially based on petroleum products with unusual abilities.

into general classes and offered as examples of the inherent possibilities in refinery left-overs. A few of the more important examples come under the heading of naphthenic acids, petroleum resins, and petroleum sulfonates.

NAPHTHENIC ACIDS—In the refining of certain west-coast gasolines and kerosines, it is necessary to scrub from them certain odoriferous and corrosive organic compounds known as "naphthenic acids." These acids are formed by nature and are very similar in chemical composition to fatty acids. Like fatty acids, they can be converted to soaps, in which form they have their greatest use.

Lead, manganese, and cobalt soaps of naphthenic acids are excellent paint driers because they catalyze the setting of paint and varnish films. In addition, copper soaps of naphthenic acids are extremely useful as fungicides and insecticides. The petroleum industry markets sizable quantities of these copper naphthenates dissolved in either petroleum solvents or in ammonia for the treatment of wood and various cotton and cordage materials.

When impregnated with small amounts of copper naphthenate, cellulose products become resistant to attack by mildew and other fungi, teredo, termites, and many related insects. In this preservative treat-



Synthetic rubber for printing rolls takes large proportions of plasticizer oils

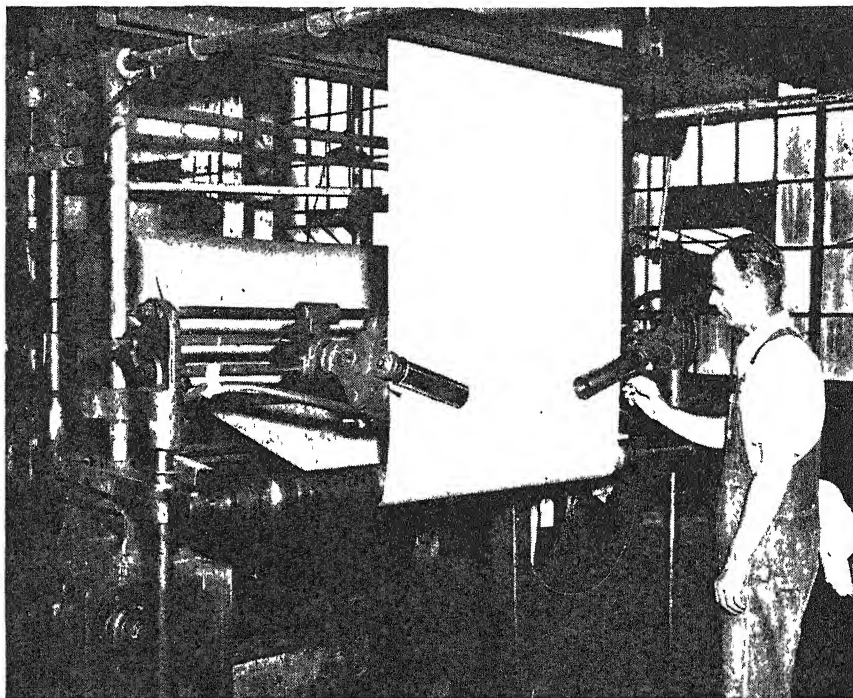
ment it is actually the copper which is the active ingredient, but its action is intensified by combination with naphthenic acids. A great variety of articles have been so treated, including sand bags, tent material, ropes, tent shrouds, camouflage netting, marine hawsers, bottoms of wooden ships, marine pilings, fish nets, and tobacco netting.

Other by-products from petroleum which have found wide use in industry are the so-called "petroleum resins" which are materials extracted from gasoline to reduce gum-forming tendencies. As a by-product, however, they are useful because of this characteristic, and upon exposure to air they dry to hard varnish-like films. Hence they are employed as extenders for difficult-to-obtain paint- and varnish-making oils, are applied to metals as protective coatings, and serve as binders for sand in preparing foundry cores for casting metals. In the latter use, petroleum resins burn out cleanly once they have been properly blended for the job in hand.

PETROLEUM SULFONATES—Mineral oil sulfonates are a third group of important by-products. Chemically, they are mixtures of sodium soaps of sulfonic acids, formed in the refining of petroleum oils with sulfuric acid. Depending upon their molecular weight, which in turn is related to viscosity, they are either water-soluble or oil-soluble in nature. The water-soluble sulfonates are powerful wetting agents and detergents, and have great utility in a myriad of applications. One of the main uses of a wetting agent is in the dyeing of textiles where it is essential that water will wet the cloth rapidly and uniformly and permit it to become evenly dyed to the proper shade. Other textile processes, such as shrink-proofing, also require these wetting agents.

Mineral oil sulfonates of the detergent type are used as important ingredients in special hard water- and salt water-resistant soaps, and in many of the familiar domestic cleaners. Mineral oil sulfonates of the emulsifying-agent type are useful for the manufacture of self-emulsifiable oils, such as cutting oils, and also many of the newer type rust preventives.

Rust preventives are of extreme importance in many phases of industry's activities. Practically all metal articles such as precision parts, instruments, tools, replacement parts for automotive and aircraft engines, and machine tools must be protected against rusting with products which can be removed before the articles are used or will not im-



Wetting oils are essential to many textile dyeing and shrink-proofing processes

pair operations if allowed to remain. This is accomplished by coating them, or at least their most susceptible parts, with a rust-resisting film of one of a great number of special compounds designed for this service.

Practically all of the commonly-used rust preventives have a petroleum base of oil, petrolatum, or wax which is commonly compounded with other materials to enhance its properties. Products of this type are available to give protection against all degrees of rusting—indoors, outdoors, in the rain, in the sun, and on exposure to salt water. Rust preventives are highly specialized products because such a diversity of service conditions must be met and because such factors as the ease of application and removal, and the type of film required must be taken into consideration.

UNCOMPOUNDED OILS—Most of the products mentioned thus far are compounded materials that were developed for specific uses. In addition to these, the petroleum industry produces a wide variety of uncompounded oils which are extremely valuable in processing applications.

For years, the industry has produced a number of highly refined oils such as the so-called "white oils" which are used for medicinal purposes. Because these oils are so pure, and so bland in reaction, they find other applications in cosmetics, hair oils, ointments, and even in animal feeds. Other less highly purified oils made by various methods of refining are employed in packing houses for slushing chutes, tables,

knives, and hooks during shutdown periods. Such products are also used as ovicides in tree sprays, as impregnants for wrapping papers and fruit wraps, and in the preservation of eggs.

The rubber industry is a large user of uncompounded petroleum products, since it consumes at least one part of petroleum for each six or seven parts of rubber. Were it not for petroleum products, it would be virtually impossible to convert many of the basic synthetic rubbers into useful articles of trade. For example, it was only when the rubber industry employed certain special asphalts that it was able to produce a GR-S tire which would approach a natural rubber tire in wearing and aging qualities. When petroleum products are compounded into rubber they assist processing and may impart such desirable properties as long life, flexibility at low temperatures, softness, and resistance to abrasion to the vulcanized articles. A number of synthetic oils have also been produced from petroleum which have found use in specialized rubber compounding operations.

Two other synthetic oils made from petroleum have unusual applications. The first of these is an oil employed for the inspection of raw quartz which is to be cut into quartz oscillators that control wavelength in electronic and radio equipment. The oscillator crystals can be made only from sections of raw quartz crystals which have no internal imperfections, and in addition must be cut at very definite angles with respect to both optical and electrical axes of the crystals. The crystals

must therefore be inspected, but since most raw quartz is scarred and has many opaque surfaces, careful study of the interior is often impossible. This, however, can usually be accomplished by immersing the quartz in a liquid having the same refractive index, upon which the crystal boundary becomes invisible. Since light is not bent in passing through the liquid-solid interface, surface flaws no longer obscure the internal defects. Such inspections cannot be accomplished with conventional petroleum oils because of their low refractive index, and consequently this operation was originally accomplished with chemicals which are highly odoriferous and somewhat irritating to human skin. Later, a petroleum product was developed in which these undesirable properties were reduced appreciably without loss in inspection efficiency.

The second synthetic oil is one that is being employed for the control of mosquitoes. Heretofore, the commonest methods of chemical control were to spray infested bodies of water with fuel oil, kerosine, or crankcase drainings. This treatment is effective because mosquito larvae breathe at the surface of the water, and are smothered when their respiratory organs become filled with the surface oil. The main drawbacks to the surface treatment are that on large areas, the oil blows away with heavy winds or evaporates in warm weather. As a result of these adverse conditions, oiling must be repeated every ten days or two weeks to ensure the continuity of the surface film.

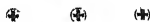
Recent studies have been made of mosquito control with a synthetic oil which is heavier than water. This product, applied in emulsion form, has been used successfully for controlling pest mosquitoes of the culex and culicini families. The larvae of these tribes feed on the bottom, and for unexplained reasons are attracted by the oil, feed upon it, and soon become poisoned. The use of an emulsion of this high-specific-gravity oil overcomes the drawbacks of surface oils, because wind will not blow it from the surface nor will it evaporate. Treatment of infested areas with the synthetic product need be made only a few times a season instead of every ten days.

All in all, the applications of petroleum by-products and process products are almost unlimited in scope. They touch on nearly every phase of industrial activity and, indeed, are vital to many. It should be emphasized, however, that the use of these products is becoming far from a hit-or-miss proposition.



Photographs courtesy
Socony-Vacuum Oil Company
Wax emulsion protected upper potato
in storage Lower potato untreated

In most cases, the sequence is one of establishing the problem and its contributing factors, analyzing the vulnerable points, and then compounding or adapting a specific petroleum product to its solution.



EAST COAST OIL

*Still Sought in Second
Test Off Carolina Shores*

PLANS to continue the search for oil in North Carolina were recently announced by the Standard Oil Company of New Jersey. The decision was based on information obtained from the first test well at Cape Hatteras.

It was explained that even though the first well failed to encounter signs of oil or gas, the geological findings justify additional exploration. Two sands which produce oil in the Gulf-Coast area were found to be present at Hatteras and to have favorable qualities. These sands were identified as the Lower Black Creek and the Massive Tuscaloosa, and were found at approximately 4000 and 6500 feet respectively. Further, these sands were found in association with marine-type shales—the type geologists consider to be possible source beds of oil. Additional seismograph work for the purpose of attempting to locate a definite structure capable of containing oil therefore seems justified, and work in Pamlico Sound will be

started in the immediate future and will continue for a number of months.

According to the Standard Oil Company, a second exploratory well will be drilled in the area if the seismograph results are sufficiently encouraging. It is considered probable that such a well might be started within the next three or four months. The site will be determined by the technicians' interpretations of the new geological and geophysical work.

FORM SPREADERS

*Easily Pulled if
Greased Before Using*

AUTOMOTIVE grease is now being used as a lubricant for the spreader ties which are used to stabilize concrete forms. Spread in a thin coat, 1/32 to 1/16 inch thick, over the entire surface of the tie, except (to prevent staining) that part of the tie which is closer than one inch to the face of the finished wall, the grease is said to permit easier removal of the ties. In the summer Marfak grease of hard consistency, known as the No. 5 Grade, is used, but in the winter a medium or No. 3 Grade must be used.

After the concrete sets in the form, the ties are pulled out from which ever side of the wall is to be left unfinished or unexposed. If the ties are properly withdrawn, the holes may be filled with grout from an air-pressure gun, the resulting wall then being solid and uniform throughout. Moreover, by the use of such a lubricant the ties are removed undamaged, and can be reused, thus adding to the economy of construction.

OIL BURNER FUEL

*Heats More Efficiently
with Better Air Mixing*

COMBUSTION heads for domestic oil burners that are another step towards utilization of all the heat available in a gallon of oil are the outgrowth of recent research in oil-air mixtures. Increased burning efficiency is achieved by more thorough mixing with a consequent reduction in the amount of cold air intake required. As explained by Shell Oil Company, Inc., instrumental in the research program, excessive quantities of cold air intake tend to cool the combustion chamber and permit a large portion of the heat to escape by way of the flue. Because of the thoroughness with which oil and air are mixed, smoke and carbon deposits are virtually eliminated when the burner is properly adjusted.

Flying's Easier, Now

Private Aviation has Shed its Aura of Glamor, Now Aims at Sounder Business Based on Comfort, Safety, and Satisfied Customers. Better Training Methods Help; So do Easy-To-Fly Planes, and Lightening of Government Rules. Limited Airport Facilities Remain a Major Problem

By ALEXANDER KLEMIN

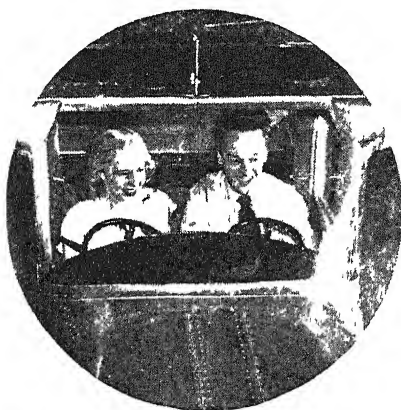
Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

FLYING, once considered a hazardous sport calling for super-human physical endowments, today requires no more balance and muscular coördination than riding a bicycle, no more judgement than driving an automobile well. Moderate physical capacities, coupled with reasonable alertness and the ability to make decisions, are all that is necessary for routine private piloting.

More important than unusual physical characteristics, is the training the prospective pilot receives. Fortunately, time has brought changes, and the poorly managed training operations of the "barnstorming" days have yielded to well-regulated systems of instruction. Instructors, who have been required to learn efficient teaching methods as well as flying, take pride in students who solo quickly. Airport operators have awakened to the "penny-wise" foolishness of prolonging flight instruction for the sake of the few dollars profit gained by

additional hours of unneeded training. In this case, the better business is to teach the student quickly and well so that he will want to purchase a plane. A satisfactory business relationship means another customer for hangar space, service, and fuel at a later date; a disgusted student usually means another person with a cooled-off enthusiasm for private aviation.

Aircraft manufacturers are also



Warm, quiet, and roomy cabins (left), plus clear vision (above), make learning to fly modern planes a pleasant, if not heroic, task. Plane shown is new Cessna model

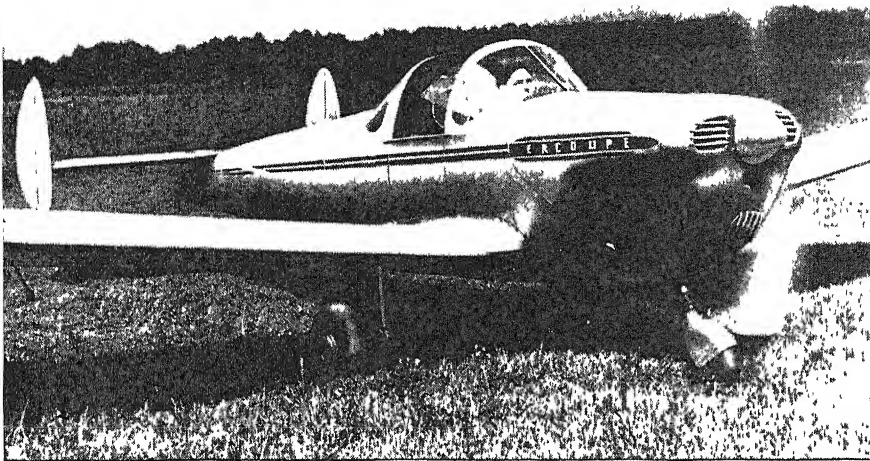
• LOOKING AHEAD •

New comfort features in personal planes may "taste like more" to buying public. . . Accessories, instruments, attractive interiors will be competitive selling points. . . Instruction may be chalked up to "sales" cost. . . Safety planes will eventually triumph. . . Simplified controls are as inevitable as were four-wheel brakes on cars. . . Continued freedom from government restriction hinges on sane flying, fewer mishaps.

showing an aroused spirit of co-operation with new pilots. Attractive, interesting, and thoroughly understandable instruction booklets provide the student pilot with something he can study at home, and aid him in overcoming the embarrassment of the novice who hates to admit a complete lack of knowledge. Some of these booklets illustrate complete step-by-step procedures for all the maneuvers of ordinary flight.

BETTER PLANES—With all of the additional training skills and aids, however, private flying would not have reached its present stage without genuine improvement in airplane design. The changes are sometimes small and occasionally very large, but all of them are significant because they are predicated on knowledge gained from experience. There is usually a well-established and substantial reason for the design features of any given airplane.

An example, still in the training field, is the shift from the noisy, uncomfortable, and thoroughly unhealthy open cockpits of several years ago. Under such conditions even the most elementary communication between instructor and student was difficult. Now, enclosed, heated cabins, sound-proofing, properly-arranged seating, and a full view of the instruments by both student and instructor make learn-



Spin-proof, tricycle-gear Ercoupe is easy to taxi, steers like an automobile

ing to fly much more comfortable. In addition, the student receives more for his money because he can ask questions and talk with the instructor while in the air.

The general flying qualities of the modern private airplane also help. Early private planes had little reserve power, and were easy to stall. Their flat climb made hangars or trees loom large as mental hazards for the pilot, and the lack of brakes created a feeling of helplessness during fast landings. In addition, controls were apt to be slow or "loggy." Thus, the plane would lag in entering a desired maneuver and the pilot would become impatient and push the control too hard. When the control did take hold, the ship would move too violently. "Over control" was one of the worst faults of the early fliers and also one of the most difficult to cure.

Capping this sluggishness of control was a lack of inherent stability. Planes refused to fly "hands off" and mental or physical relaxation was impossible. Trim tabs, now used to balance the craft for varied conditions of flight were also missing. Finally, among the major faults of yesterday's planes, were landing-gear shock absorbers which did not sufficiently absorb shock. The energy of landing was not dissipated and ships would bounce back into the air after landing. Modern planes have eliminated the foregoing troubles and many others.

EASIER TO FLY—Modern private airplanes are stable—longitudinally, laterally, and directionally. If the aircraft should nose down involuntarily, the large horizontal tail surfaces and other properly distributed forces will bring the ship

back to its level position without action by the pilot. Lateral stability is provided by dihedral, the term applied to the slight raising of the tips of the wings. Directional stability is assured by large vertical tail surfaces. It is possible to fly a modern plane without touching the controls for long periods of time.

The controls of the old training planes were not only slow in response but they were hard to move. In today's airplanes, rudders, elevators, and ailerons are so beautifully balanced, with a part of their area ahead of the hinge, that little more than finger-tip control is needed. In addition to efficient, automobile-like wheel brakes, there are brakes on the wings in the form of flaps. With the latter, the flier can steepen the landing glide without nosing the ship down. This decreases the landing speed and permits the use of smaller fields. A variety of shock-absorber designs are used to dissipate landing energy and thus eliminate bouncing.

Outstanding, too, are the tricycle landing gear and swiveling nose wheel, which have made cross-wind landings considerably less difficult. With this design, when the nose wheel strikes the ground it swivels and brings the airplane correctly into its line of motion. Also the nose wheel minimizes any chance of the airplane nosing over; the plane can even come straight in out of the glide without flattening out except that the nose wheel will not withstand such rough treatment very long. Moreover, during take-off, the ship can run along the ground with all three wheels touching, and if the stick is held back just a trifle, the plane will take off without any further effort when it has reached a

certain speed. There is a penalty to this automatic take-off. It is apt to be longer than in the classical take-off from the two-wheel attitude.

SPIN-PROOF—The one aerodynamic feature which overshadows all others is that a good many of the modern planes are highly resistant to the stall-spin—responsible for so many accidents in the past. The principles of the spin-proof plane have been understood for many years, but the application of these principles has been slow. To make a plane stall- and spin-proof, said the experienced fliers, robs the pilot of some of his unrestricted power. More progressive pilots, on the other hand, point significantly to the rather permanent restriction that often accrues to those who spin too close to the ground.

Prevention of the stall-spin is partly mechanical in that the upward travel of the elevator must be partially limited. It is the unlimited upward travel of the elevator which can bring the nose of the aircraft up to too great an angle of attack, causing the wing to stall and lose its lift. Likewise, the ailerons can be restricted since, when pulled down beyond a certain point, they do not improve the rolling moment but increase the turning tendency too much.

The aerodynamic trick in eliminating the stall-spin lies in washing out the tips of the wings; that is, introducing a slight twist and thus reducing their angle of incidence at the outboard portions. When this is done, the center of the wing not the tips stall first. As a result, the tips retain their lift and control any rolling tendencies that develop. These simple aerodynamic precautions have proved surprisingly effective; planes of this sort cannot be stalled and spun and a great cause of accidents is thereby removed.

OTHER FEATURES—Substantial improvements have been made in the direction of visibility. With inline engines, plus the liberal use of Plexiglas, forward vision is now remarkably good. As a bonus feature, well-fitted windows keep out cold air and allow the pilot to dispense with a flying suit. Since most private flying is done under better than "instrument weather" conditions, an unobstructed horizon reference line is vital. Thus, with the aid of visual reference alone the private flyer can tell whether he is flying level, climbing, or banking. Few private planes carry extensive navigation instruments, but all the necessary instruments are there, clearly in sight and grouped according to a

logical plan. A typical instrument panel incorporates an engine tachometer and an air-speed indicator placed naturally together at the left. The compass is in the center of the panel, and to its right is the altimeter. Compass and altimeter are the private pilot's simple navigational instruments and they logically go together. Oil temperature and oil pressure gages are further to the right near the engine primer and the cabin-heat control. Seats are adjustable to accommodate the short and the tall. Controls, single or dual, are well designed relative to the occupants, doors are near the ground and easy to get in and out of.

PILOT REGULATIONS — Much of the unpleasantness of examinations and difficulties of obtaining an Airman Certificate from the Civil Aeronautics Administration have been removed. In order to fly, a person is required to obtain an "Airman Certificate" comparable to the license issued to motorists. Solo flying may be done on a "Student Pilot Certificate" which has been endorsed by a rated instructor, but it is only with the Airman Certificate that a private pilot can give a ride to his friends, and then only without pay

Physical examinations need not be made by a specially designated flight surgeon. A family physician, if preferred, may fill out a simple form. Common physical deficiencies will not bar a prospective flyer, nor will the wearing of spectacles. Any normal person over 16 can qualify as a student pilot, and when over 17 can seek an Airman Certificate. Solo flights may be made after eight hours of dual instruction at any time the instructor thinks the student qualified, but before appearing for a flight examination ten hours of dual instruction and 30 hours of solo flight are required. With the "spin-proof planes" however, seven hours dual and 20 hours of solo suffice. Examinations in meteorology and navigation have been discontinued; examinations are now limited to simple questions on Civil Air Regulations.

From the over-all viewpoint, many things have been done to make flying easier. Systematic instruction, good flying equipment, and lightened government regulations all help. There are, however, some remaining difficulties. Landing fields are not available in sufficient numbers and the all-around safety record of private flying has not yet become entirely satisfactory.

sides aircraft. One such use is suggested in the instrument field where reciprocating motion is sometimes avoided by complex rotational hook-ups.

CHANGED AIRCRAFT RULES

*Drop Stall-Speed Limits;
Emphasize Other Factors*

STALLING speed requirements for transport aircraft were recently removed by the Civil Aeronautics Board. This action, which on first thought may seem surprising, was intended to eliminate what might become a severe handicap to greater performance and economy in transport airplanes. Long considered a vital safety factor—high stalling speeds are reflected in higher landing speeds—stalling speeds have moved consistently upward with the evolution of aircraft design. Compared with 30 miles per hour for the Wright brothers' planes, the popular DC-3 stalls at a speed close to 70 miles per hour.

It is noteworthy, however, that safety has also continued to improve through the years. This is, in part, due to a greater recognition of the part played by other operating requirements such as the minimum rate of climb with all engines functioning, and the minimum rate of climb with one or more engines inoperative. These factors are closely tied with stalling speed but are more truly representative of desirable airplane performance from the standpoint of optimum safety.

ANTI-FRICTION

*Bushings Give Free
Reciprocating Action*

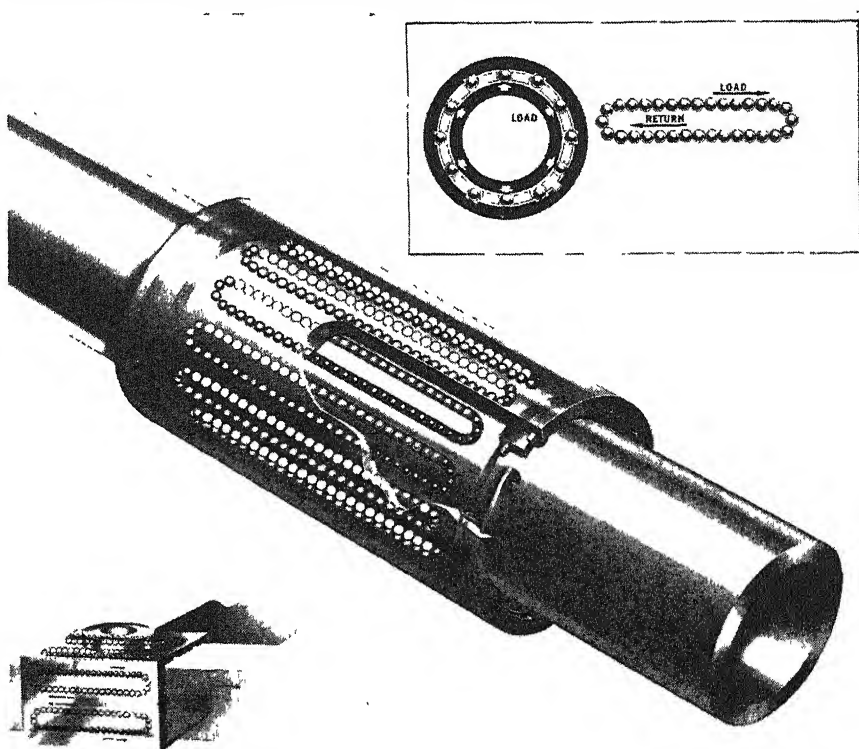
BALL and roller bearings, traditional reducers of friction, can ordinarily be used only on rotating parts in journals, thrust bearings, and the like. In aircraft, however, it is sometimes important to reduce friction in reciprocating motions, as in engine controls, in the operation of flaps, or in the actuation of landing gear.

Now a new mechanism, termed a "ball bushing" has been introduced to reduce friction in the reciprocating travel of mechanical members in a bushing. Members whose contours are round or square, or a variation of these shapes may be accommodated by variations of the design.

The ball bushing contains a series of ball circuits. One side of the circuit carries the bearing load, the other side returns the balls in a clearance provided in the outer race member of the bushing. The continuous bearing is reported to prevent cocking or binding on the shaft because the balls always remain centered under load, while rolling contact and sealed-in lubrication ensure long life. Ball circuits can be infinitely varied for different

load capacities and shapes of bearing members.

The principle appears well adapted for many applications be-



Balls move in closed circuit, one side carries load, other side returns balls

Chemicals Grow on Trees

In Searching for an Answer to Their Marginal Economic Status, Wood Distillers have Uncovered Some Highly Interesting Wood-Tar Products. What Can be Done With Them, How to Recover Them, and Various Other Problems Make "Question Marks" of These Complex Chemicals

By D. H. KILLEFFER
Chemical Engineer

WOOD distillation — modern version of the ancient art of the charcoal burner—enjoyed a brief respite during the war from the devastating economic attacks of synthetics on its slim profits. Indeed, the slender margin between costs and income has frequently put this industry in grave economic danger. Synthetic processes have successively attacked its principal products, and have left the wood distillers' position quite unenviable. But the peculiar upset situations growing out of war provided an opportunity for the wood-distilling industry to do something about this basic problem. Researches lately completed suggest that new products, hitherto left in low-value tars and tar oils, may add enough profit to convert red ink figures to black.

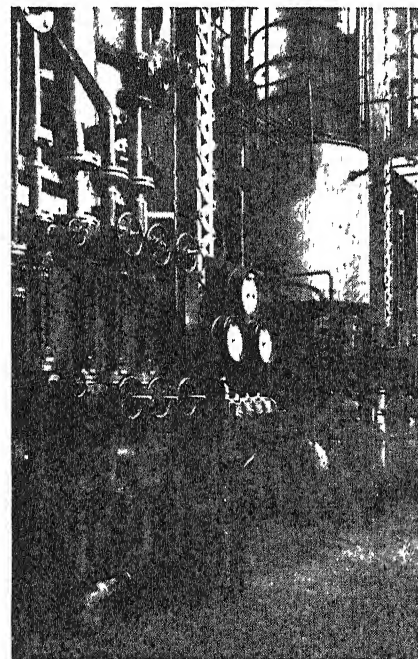
WOOD TARS—Actually, the entire matter of the chemical products of wood, as distinct from its structural

applications, needs to be reappraised. In general, wood chemistry progress is not as well recognized as is the tremendous recent growth and importance of wooden structural members of a new kind developed through the remarkable co-operation between wood, the oldest structural material, and synthetic resins, the newest.

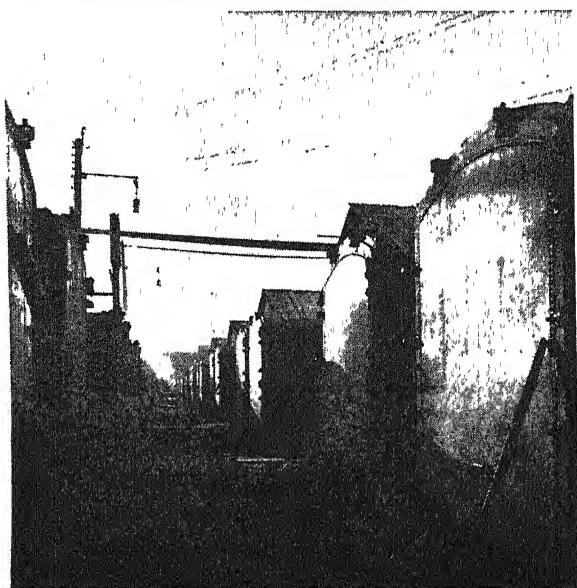
The most recent phase of wood chemistry digs deeply into the tar-products of distillation and comes up with some interesting and strange new stuffs that will be extremely difficult to synthesize. So far, little more is known of their potential values than that they can be obtained. Often, that is enough, for it is rare indeed to unearth a complex chemical compound that is not exactly the answer to someone's particular problem. If it should prove to be like that in this case, then the wood distillers may be able to add to their slim profits a tiny

• LOOKING AHEAD •

Wood-distillation for chemicals is still young. . . Not yet even an industrial entity. . . But its future, on a long-range basis, appears good. . . Wood is one of few replaceable raw materials. . . Its tar products are not open to easy competition or duplication. While still too early to predict specific uses, it seems inevitable that continued research must find them. . . . Until then, far-seeing industrialists will "watch wood."



Photographs courtesy Cliffs
Dow Chemical Company



Control station of
fractionating columns
for wood-tar
distillation (right)
indicates the
complexity of such
processes. Large
retorts (left) are
further representative
of extensive
equipment required
Retort doors
open to receive
wood on cars

increment that will mean success. To understand what is going on, it is necessary to go back a few decades and recall the recent history of this industry.

Basically, the wood distillation operation consists of heating wood in an oven or retort to drive off everything that is volatile, leaving charcoal. The volatile matter, amounting to about 64 percent of the weight of the wood, consists of acetic acid, wood alcohol (methanol), acetone, a considerable quan-

Products from Hardwood Carbonization

	Yield/Cord	Pounds	Wt %
Charcoal (17.5% volatile)	540 bu	1080	36.0
Acetic acid (including formic and propionic)	143 gal.	125.8	4.2
Denaturing grade methanol + methanol + methylacetone	9.3 gal	61.4	2.0
Tars and oils	38.4 gal	366	12.2
Noncondensable gas	7260 cu ft.	650	21.7
Water of pyrolysis and loss	23.9

tity of non-condensable gas and wood tars, and oils. Synthetic processes, and others having high convenience values, have step by step destroyed the one-time monopoly that wood distilling enjoyed respecting these products. Acetic acid is now cheaply synthesized from acetylene, methanol from water gas, and acetone can be either synthesized from acetylene or produced by fermentation from grain.

Formerly it was customary to subject the wood-tar product to only the simplest and most casual kind of separation to yield constituents of low value. Now that is being changed. Wood distillers have come to realize that wood tars contain chemical compounds so curiously and intricately fashioned by Nature that man's ingenuity will be sorely taxed to duplicate them synthetically.

TECHNIQUES—The problem now is the economical separation of these valuable constituents of wood tar, which contains great numbers of closely similar compounds which are extremely difficult to separate in the type of equipment ordinarily available in the wood-distillation industry. As a matter of fact, the precision stills of the type required have been available for only a very few years; they were built to meet the extraordinary demands of the modern petroleum-chemical industry. The remarkable war-time achievements exemplified by synthetic rubber and aviation gasoline are based to a considerable degree on the perfection of distillation methods of a precision and nicety never before realized. These methods and tools are now available to other industries and promise results quite as revolutionary elsewhere as in their original applications.

Recalling the remarkable values dug out of coal tar and out of petroleum by the industries now devoted to their exploitation, it might be assumed that the case of wood tar will be similar. But the situation is scarcely a parallel. The known compounds in wood tar prove to be more intricate and elaborate in their molecular structures than the common ones of either coal tar or petro-

leum. Obviously the greater the intricacy, the more difficult will these compounds be to synthesize, and cheap, easy synthesis is the *bête noir*, the haunting ghost in the closet, of the wood distillers.

If the compounds recoverable from wood tar, which is produced to the extent of some 12 percent of the weight of the wood distilled, should prove as useful as is now hoped, the inducement for synthesists to

New Compounds from Wood Tar

Guaiacol
Creosol
Butyrolactone
Acetal acetate
Butyric acid
Crotonic acid
Maltol [3-oxy-2-methyl-(4)-pyrone]
2-Hydroxy-3-methyl-Δ²-cyclopentenone
2,6-Dimethoxyphenol
Tiglaldehyde
Methyl isopropyl ketone
Methyl ethyl ketone
Methyl furyl ketone
4-Ethylguaiacol

destroy the profit in their recovery by making them will be rather less than it was for chemically simpler methanol, acetic acid, and acetone. Furthermore, and this may be highly significant, the basic recovery process will necessarily separate several groups of products which will be relatively far easier

to purify by other means from this point on than they were from the original much more complex mixture. Thus there will be several products simultaneously contributing to the new income for the industry, and not just one or two.

COMPLEX PROBLEMS—The possibilities latent in the complex mixture that constitutes wood tar are many. Researchers Goos and Reiter of Cliffs Dow Chemical Company, recently reported 183 compounds found to exist in the products of distillation of hardwoods. These compounds are listed in the accompanying tabulation by chemical types, but it must be realized that the quantities of most of the member substances are present in only minute proportions.

Fractional distillation, employing highly efficient modern stills, is an important step in separating a complex mixture of this type, but without the help of other separating processes based on other differences of properties, distillation alone can effect only a partial resolution of the complex. Thus it is necessary to utilize chemical differences between the compounds involved to supplement precision distillation in effecting the most complete separations required. For example, forming compounds of alcohols with a fatty acid may yield a mixture of esters that are far more readily separated than the alcohols themselves. Once the separation of the esters from each other is effected (by distillation, for instance), recovery of the alcohols from them by treatment with alkali or steam is a simple process.

While this suggested process oversimplifies the separating problem, it indicates the direction of thinking and processing that seems now likely to provide the chemical industry with a new group of raw materials,

Chemical Types of Compounds from Wood Distillation

ACIDS, ALIPHATIC		ETHERS		KETONES	
Saturated	19	Aliphatic	1	Aliphatic mono	9
Unsaturated	9	Aryl monohydroxy	1	Aliphatic di	4
Other	6	Aryl dihydroxy	9	Unsaturated mono	3
ACETALS	3	Aryl trihydroxy	7	Aliphatic-furyl	1
AMINES				Cyclic saturated	9
Aliphatic	3	ESTERS		Cyclic dione	1
Pyridines	3	Aliphatic	8	Cyclic unsaturated	6
ALCOHOLS		Other	4		
Aliphatic	6	Lactones	2	MISCELLANEOUS	
Unsaturated	3	FURANES	9	Oxypyrene	1
Cyclo	6	Hydrofuranes	2	Glucosan	1
Furyl	1	HYDROCARBONS		Cyclic ketol	1
ALDEHYDES		Paraffins	8	Other ketol	1
Aliphatic	7	Unsaturated	2	PHENOLS	
Cyclo	2	Aromatic	7	Mono	7
Furyl	4	Condensed-ring	3	Di	1
Unsaturated	3	Terpenes	8	Tri	3

and the wood distillers with a possible new source of the added revenue they will need to survive the peace. Goos and Reiter, quoted above, report that the methods are now available to supply some 14 new compounds from wood tar as a starter. Their list is given in an accompanying table.

These compounds are in addition to the customary products of the wood distillers: acetic acid, charcoal and activated chars of several varieties, creosote and creosote oils, methyl acetone, pyroligneous acid, wood alcohol, and a few others. The new products would be recovered from the creosote oils and tars, and to a lesser extent from the further purification of pyroligneous acid. Whether they are recovered by wood distillers, who will have to rearrange their plants for the purpose, or by chemical manufacturers already equipped in part for this kind of operation, remains to be seen.

WOOD SUGARS—These possibilities in the greater chemical utilization of wood supplement other developments that have also grown somewhat in significance during the war years. Production of wood sugars by the acid treatment of wood wastes was undertaken during the past few years to supplement customary sources of alcohol, required particularly for synthetic rubber production. While this is related only through the parental raw material, wood, with the products mentioned above, a possible new industry may be built upon it. This is already having a curious and interesting corollary.

Production of sugar from cellulose by acid hydrolysis is not new, but was employed in this country during World War I as a source of ethyl alcohol. The process proved uneconomical under peace conditions and was abandoned here. In Europe, the need for alcohol and for a source of even low-grade sugar was greater, and consequently the process was advanced to a working basis there. Efforts to re-establish the much-modified process here were unsuccessful until World War II magnified the demand for alcohol to such an extent that some alarm was felt as to the ability of ordinary sources to meet the needs. Then the so-called Scholler process was put into operation here.

One essential difference between the wood sugars and those found in molasses is that the former contain a comparatively large proportion of compounds—the pentoses—that are not fermented to alcohol by the ordinary yeast, *Saccharomyces cerevisiae*. Consequently, these sugars

remain in the slop from the alcohol stills and pollute the streams into which it is emptied. Not only do these unfermented sugars escape from the process, but their quantity is great enough to be serious both as an economic loss and as substantially affecting the cost of waste disposal. An answer has been found in the growth on the still slop of a different strains of yeast which destroys the objectionable sugar content of the slop and at the same time grows mightily. Yeast of the *Torula* family thrives on the sugars left by the ordinary yeast and the *Torula* yeast constitutes a valuable high-protein feeding stuff. European stock raisers have found yeast a valuable supplement to animal feeds and so, too, may American agriculturalists. If that proves true, and the new feed is acceptable here as it is in Europe, it is possible that the added value thus given production of the wood sugar-alcohol industry may provide for it a permanent place in our industrial economy.

FUTURE UNKNOWN—These two industries based upon wood have heretofore been in the marginal class, economically. Wood distillation has been just possible, and wood sugar-alcohol, just unprofitable economically. Both have contributed important shares to wartime necessities, but both are faced with trouble now.

Operators of these industries, realizing that success depends on doing something better soon have turned to research for the answers. Whether the present answers are complete solutions to the fundamental economic problem or not, yet remains to be seen. Whatever the future may hold for these industries, certainly prospects are the brighter for research already done and may be still brighter as more research, yet in progress, is completed.



INSULATING BOARD

*Resists Destructive Agents,
Made at Low Cost*

A QUARTER'S worth of glue is the principal raw material required to produce more than a cubic foot of a new type of insulating board. The product weighs one to three pounds per cubic foot and compares favorably with other commercial heat insulations. The process of manufacture is described as simple and yields a board resistant to most destructive agencies. Although the

board has fair strength, it is not intended to be used unsupported in structures.

In thin layers, the new product somewhat resembles flannel, but as usually made it is more like dried natural sponge which has been cut into slabs about a foot square and an inch thick. By using different fillers, the characteristics of the product can be varied between wide limits, and the curing process imparts to the glue high resistance to water, fungi, and other destructive agents. The product is suggested for insulating railroad cars, trucks, and airplanes, or wherever extreme lightness is required together with efficient insulation against heat, cold, or noise.

NON-METALLIC MAGNETS

*Of Powdered Oxides
are Light in Weight*

MAGNETS are now made for special purposes by sintering a mixture of the oxides of iron and cobalt. The special advantages claimed for these non-metallic magnets are very low electrical conductivity and light weight combined with valuable magnetic properties.

MINUTE PARTICLES

*Are Accurately Measured
by Colored Light Method*

PARTICLES as small as 0.000002 inch in diameter—too small to be seen with an ordinary microscope—can be measured rapidly and with a high degree of accuracy by a new method evolved in the laboratories of the Du Pont Company.

The procedure consists of passing different colors of light through a suspension of the particles in a liquid, and then measuring the proportion of light of each color which emerges. Suspensions containing particles of different sizes vary with respect to their transmission of different colors. From the data obtained in this fashion, not only can the average size of the suspended particles be calculated, but a curve can also be obtained which shows the relative amounts of each particle size present.

The entire operation requires only two hours—a considerable advantage over previous techniques.

Measurement of particle size has wide application in industry. It is of primary interest, for example, in research on pigments for paints and enamels; in the study of synthetic rubber and plastics; in protein and other biochemical work; and in the manufacture of catalysts, as well as in a host of other industries.

Sight At Night

Presaging Fulfillment of the Age-Old Desire to "See Through" Fog, Smoke, and Dark, Come Reports of Infra-Red Beams that Penetrate 600 Feet of Blackness. Quite Simple and Inexpensive, Headlights Without Light, and Eyes that See Heat may Guide Trucks, Buses, and Airliners

By VIN ZELUFF

Associate Editor, *Electronics*

MEN who drive while others sleep—the truck drivers, railroad engineers, pilots, and others who know the dangers of darkness and fog—may soon gain "extra" vision with new infra-red night sight. Beset by time schedules paced out on clear nights, drivers fear fog as a deadly menace, and operators of common carriers find it boosting the costs of operation at unexpected times. Patches of fog in the low areas along highways on otherwise clear nights force intermittent slow downs and plague drivers trying to keep their schedules.

INVISIBLE RAYS—Fog-piercing infra-red beams were used during the war to detect enemy night infiltration of our lines. One such instrument, called a sniperscope, resembles a telescope unit mounted on a .30-caliber carbine. The infra-red light source is suspended under the carbine so that the invisible rays project wherever the gun points. Infra-red rays, reflected from the target, are focused by an objective lens in the telescope to form an image on a chemical coating on one end of a special electronic picture-converting tube. This coating is sensitive to infra-red, and as the rays strike it, electrons are released in direct proportion to the light rays distributed over its surface.

These electrons are attracted to a positively charged coating at the other end of the tube and their passage to this second coating is accelerated by an electron-multiplier arrangement in the center of the tube. The second coating is similar to the phosphor coating on the screen of the conventional cathode-ray tubes and, as the electrons strike this, they produce a visible, greenish image of the objects viewed through the objective lens.

To the military services, the important feature of the infra-red equipment is that the enemy does not see the tell-tale infra-red light that spots him. To peace-time industry, however, the prime advantage of the equipment is that infra-red rays pierce fog, mist, smoke, and other obstructions to human vision. In addition, any heated object in the field of view produces its own infra-red radiation and will appear with a still greater intensity on the viewing surface. Thus, a lighted cigarette shows up as a two-inch circle of light. Japanese soldiers who made tea at night on the ordinarily invisible flame of a Tokyo tea boiler unwittingly offered themselves as perfect targets in the center of a prominent circle of light.

Although infra-red vision equipment was only recently released from military secrecy, much of the

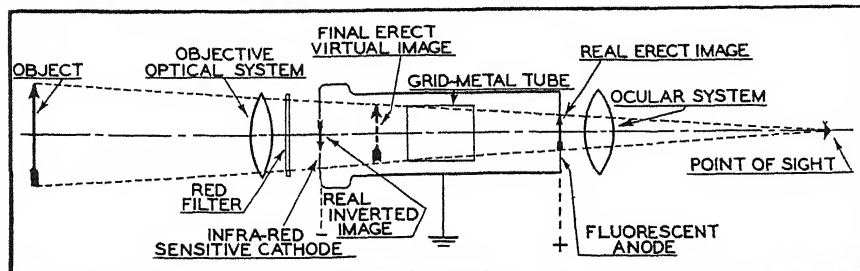
• LOOKING AHEAD •

Faster schedules, lower rates, in all fields of transportation when allowances for fog delays can be cut. . . Insurance rates lowered because of greater safety. . . Vehicles and trains spaced closely without overtaking-collision danger. . . Perhaps infra-red vision will greatly simplify blind aircraft landings. . . Help solve traffic problems at fog-bound air fields.

development work has been done and package units for consumer sales should not be long in coming on the market. In fact, the advantages of the infra-red sensitivity in television equipment have already been described—*Television in the Dark*, *Scientific American*, January 1946.

SIMPLE EQUIPMENT—For infra-red sight, however, complex television equipment is not necessary; the sniperscope is a simple and inexpensive unit. A high-voltage power supply operating on the same principles as the B-supply unit in automobile radio receivers is used to maintain the high potential in the infra-red-sensitive electron tube. Even simpler systems were developed by German scientists during the war. Most of these devices used a picture-converting tube containing an infra-red-sensitive screen which emitted electrons, an electron-lens system that focused the electron stream, and a fluorescent coating on which the image was formed by the lens.

The picture-converting tube was used in three types of infra-red equipment: the *nachtfahrgerat*, night-driving equipment for trucks and tanks; *zielgerat*, rifle-sighting



German "picture converting tubes" are quite simple. Diagram above is schematic

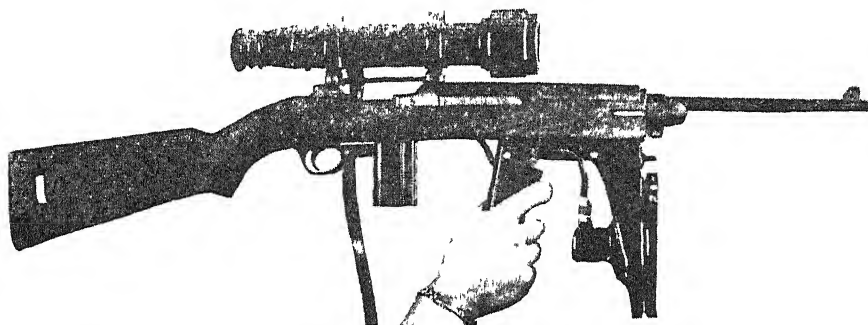
mechanism for snipers, and an aircraft experimental model *muecka*, mosquito.

The *nachtfahrgerat* was used for driving in complete blackout at any rate of speed the vehicle could maintain, and for firing at objects without the use of flares. It clearly reveals the roadway ahead for 100 yards, and most objects are discernible at distances greater than 200 yards.

The device contains a picture-converting tube called a *bildwandlerrohr*. One end of this tube consists of an infra-red-sensitive coating of a transparent cesium compound that emits electrons when in-

that corresponds to the distribution of infra-red radiation on the cathode coating. A similar action, of course, takes place in television-image tubes and fluorescent lamps.

The objective optical system forms a real image on the infra-red screen. This image, after passing through the remainder of the system, appears in its normal size for the selected distance, if the eye is held about 15 centimeters from the outside surface of the ocular. Moving the eye further or closer than 15 centimeters from the *nachtfahrgerat*, the object appears larger or smaller. This is due to the fact that the final vertical image is not at the same place, in



Sniperscope, American night gun, mounts infra-red light and scope on a carbine

fra-red light strikes it. At the other end of the tube, the end facing the observer, there is a fluorescent-coated screen on which the image to be viewed is formed by the electronic system. Light from the object being viewed passes through an optical lens system and a red filter to the infra-red-sensitive cesium coating. The latter then acts like the cathode of a conventional tube in that electrons are emitted from the opposite side according to the intensity of the infra-red radiation. These electrons are focused electrostatically by an electron lens that is equivalent to a grid at the center of the tube.

Electrons from the grid are next attracted to the positively charged fluorescent coating used as the anode. As they strike the anode, it fluoresces to form a visible image

distance, as the original object but closer, although with the eye at 15 centimeters from the instrument, it subtends the same angle at the eye as the original object.

The source of the infra-red light is a 100- or 200-watt infra-red lamp. A Fresnel lens projects the rays in front of the vehicle. In addition, infra-red filters are used to cover the headlights of the car or tank.

The red filter in front of the picture-converting tube is needed to prevent bright, normal illumination from striking and injuring the infra-red-sensitive coating. High potential must be applied to the electrodes of the electron tube to bring the electron beams to a focus within the tube, and also to accelerate the flow of electrons to give a brighter picture on the fluorescent screen. For

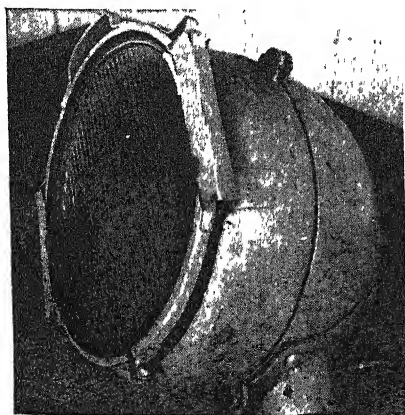
this, the high voltage is obtained from a vibrator resembling those used in automobile radio receivers, and an automobile-type spark coil is used as a step-up transformer. Two d.c. outputs are provided, one of 6000 volts and the other 8000 volts.

OTHER MODELS—A second German infra-red receiver is a small unit like the American sniperscope, that mounts on a rifle in place of telescopic sights. Called the *zielgerat*, this unit enables a sniper to pick off individual men at night. The infra-red lamp is mounted in a small reflector on top of the unit and is said to be effective up to 100 yards. The power unit uses an Edison-type battery and is carried in a regular gas-mask holder.

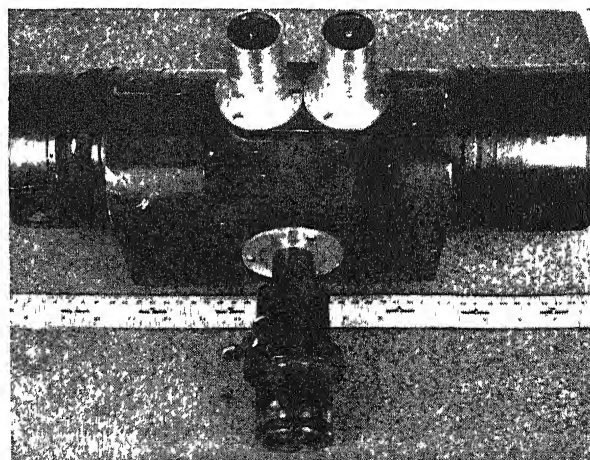
The receiver continues to operate for about 15 seconds after the power supply is turned off. This action is provided by a large value capacitor in the power supply so that the value of the applied voltage gradually decreases. Although the rifleman must stop periodically to apply high voltage, he has ample time to sight and aim.

An aircraft experimental model, the *muecka*, is a small receiver less than six inches long that was never put into production. Infra-red lights were to be installed on a plane's wing tips, so that the pilot could use the receiver to identify or locate planes near him at night.

A very simple device for observing the presence of infra-red searchlights is described by C. W. Hansell of RCA. He reports that about 10,000 such devices were produced for use by the Wehrmacht to detect anticipated uses of infra-red searchlights by the Allies. Consisting of a simple paper tube having an infra-red window and lens at one end and a sensitive screen at the other, they use no vacuum. In this case the sensitive screen has the remarkable property that, after exposure to strong sunlight, it becomes sensitive for a long time and will respond by emission



Infra-red lamp (left) and viewing scope (right) are main units of German "night driving" equipment for trucks. Road definition was clear enough for normal speeds in spite of a complete blackout



of red visible light when illuminated by invisible infra-red light. Although these simple cells do not have the sensitivity of the electron-tube system, they may also find useful applications

As peace-time production accelerates, and the long-promised new products appear, infra-red sight equipment holds definite promise for industry. Not only can the transportation field find ready use for such vision aids, but they also can be used in case of mine fires where ordinary light cannot penetrate the smoke, in chemical processing plants where gases block white light, and in burglar-detecting devices which spot, but do not warn, the intruder.



VACUUM SYSTEMS

*Checked for Leaks
With Helium Gas*

EXACT locations of leaks in a vacuum system can be accurately determined by spraying helium gas over the system while the vacuum pumps are running, and watching the indicator of a Westinghouse mass spectrometer that has been coupled into the vacuum system. So sensitive is this arrangement that it can instantly detect any helium entering through a leak. The helium nozzle is moved about until the leak detector shows a maximum reading, at which time the nozzle is pointing to the leak. Ordinarily, a mass spectrometer weighs and sorts individual molecules of different gases, but here it is adjusted to respond only to helium molecules. This electronic leak detector was used with many of the high-vacuum systems in the atomic-bomb project, and promises to have even greater importance in industry now that high-vacuum techniques are being applied to many different fields.

LIQUID LEVEL

*Shown by Accurate
Capacitance Gage*

THE principle of operation of an electronic gas gage for bombing planes, recently announced by Minneapolis-Honeywell, may find applications in a large number of manufacturing operations, in refineries, large storage vats, and even to measure the moisture content of wheat and other materials.

In the gas tanks of a four-engined airplane are mounted capacitance units which connect to an electronic amplifier and meter. Each capacitance unit consists of a piece

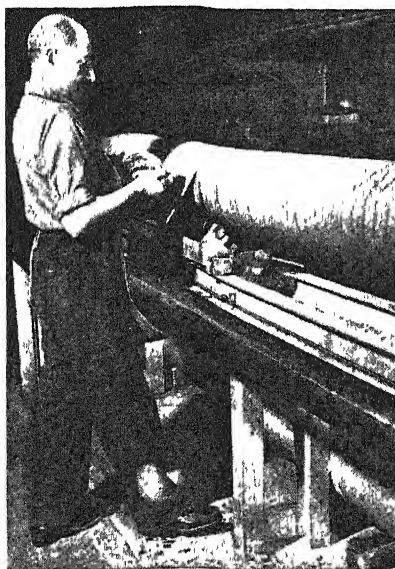
of tubing which contains two smaller pipes inside to form the elements of an electrical capacitor. Gasoline can flow inside the tubing and between the two inside pipes. The electrical capacitance of the gasoline changes with the height of the liquid within the tank unit and is measured electronically by the amplifier. Actuated by the amplifier, an indicating dial on the plane's instrument panel shows the contents of the tank in gallons.

PHOTOELECTRIC SWITCH

*Gives Remote Control
for Huge Machine*

A FIFTY-FOOT light beam controls a rotating mandrel in the making of heavy hose at the Hewitt Rubber Corporation. Part of the hose-making process involves wrapping material on a huge 50-foot rotating mandrel, this being the standard length of finished rubber hose.

To control the driven chuck which rotates the mandrel, the operator previously stepped on a wire cable



Operator interrupts light with foot

stretched the full 50-foot length, or he signaled an assistant at the chuck by a nod of his head whenever the machine was to be started or stopped. This signal was sometimes not seen or the response to it was slow, and the operator could then be caught in the machine.

Photoelectric equipment is now installed about 12 inches above the floor so that the light beam extends the entire 50-foot length. The machine is stopped instantly when the operator kicks either foot forward and interrupts the beam and the control is effective at any point along the machine. A telescopic lens of 32-inch focal length focuses the beam on the phototube.

The operator now controls the

machine with a minimum of effort, greater safety is provided, and the floor is clear of gear that might impede the operator as he walks along the mandrel.

FOILESS CAPACITORS

*Formed of Metalized
Paper, Heal After Breakdown*

A VERY thin coating of zinc, vaporized directly onto paper strips, is the basis of a new manufacturing process for making fixed capacitors used in radio and electronic equipment. The metallized paper units are about 40 percent smaller than equivalent types having alternate sheets of paper and metal foil rolled together, and production costs are estimated to be about 20 percent less.

It is claimed that the metallized units can fail many times before they need replacement, because the unique construction makes them self-healing after the insulating paper is punctured by an electrical breakdown. Developed in Germany by the Robert Bosch Company, the basic patent on the method is controlled by the Alien Property Custodian and licenses are available to American manufacturers.

RADAR ON BOAT

*Will Aid "Close Quarters"
Navigation at Night*

THE passenger-carrying night boat, *City of Richmond*, will benefit from radar navigation equipment now being installed by Westinghouse. The Old Bay Line, owner of the ship, also plans to add radar units to other ships of its fleet.

Providing a continuous map-like picture of ship traffic and shoreline conditions from 100 yards to 32 miles distant in three ranges—of 2, 8, and 32 miles distant radius—the equipment uses a seven-inch cathode-ray tube mounted in a small cabinet convenient to the watch officer's station on the bridge.

The antenna is mounted under a large mushroom-shaped plastics dome atop a 5½-foot pedestal on the wheel-house roof. Other units are mounted in the weather-proof base of the pedestal, and the receiver-indicator is in a cabinet two feet square and 48 inches high. Power is provided by a below-decks rotary converter operating on the ship's power line.

Although the antenna is designed to provide full 360-degree horizontal rotation, the stack will obstruct its scan for about nine degrees dead astern. If complete coverage aft is needed, it will be necessary to elevate the antenna.

Pin-Ball Proving Ground

When Materials Stand Up Against the Ravages of "Jive" Fans, Irate Nickle "Recoverers," and Table-Tilt Artists They've Got to be Tough. Coin-Machine Applications have Proved that Plastics can Endure Rough Treatment and still Retain Their Clean and Colorful Sales Appeal

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

COIN MACHINES—a tremendous potential field for expanding plastics applications—were given a big play by the public during the war, both for amusement and for purchasing food. And the coin-machine industry, converted almost entirely to war work, could do little more than patch the pre-war machines and hope that they would last the duration.

Now, having come out of the war with greatly improved equipment and increased plant capacity, the manufacturers of these machines are planning not only to replace the worn-out units but to increase the total number. Estimates for 1947, now set as the first post-war year

of normal output, indicate a production of 1,500,000. This figure, of course, divides into three broad fields—vending machines, juke boxes, and pin-ball and similar units.

In all of these fields, plastics promise to play an increasingly important role. However, since the reasons for the popularity of this material vary with the different groups, it is best to consider the three types separately.

VENDING MACHINES—While producers of the other two groupings of coin machines have indicated that refinements are on the way, the vending-machine manufacturers have entirely new units to offer—

• LOOKING AHEAD •

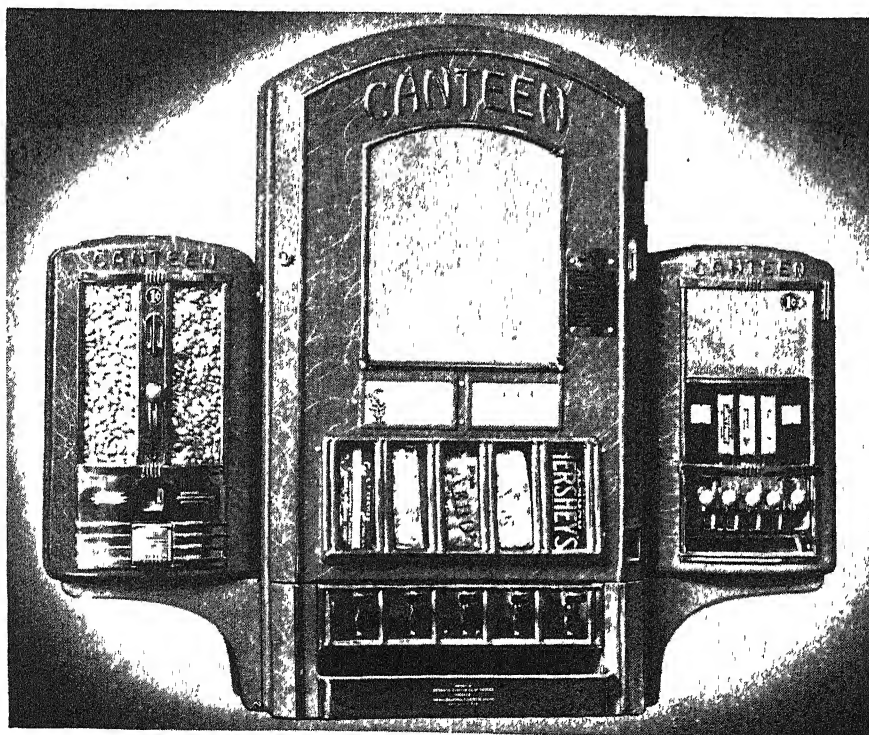
Plastics have an indisputable ability to meet-the-public. . . "Bugs" will be worked out of coin-machine uses. . . Later, more plastics parts for store fixtures, show cases, self-service units. . . Light-to-ship and eye-catching, plastics should find a place in retail-merchandising aids. . . Colors and contours, plastics features unmatched by other materials, would call buyer's attention to display.

machines that were proved by dispensing food to war-plant workers. To the familiar gum, cigarette, nut, and candy machines have been added sandwich and hot-dog purveyors.

While no one questions the service which these units rendered in war plants, there has been some question as to their future. Many men in the industry, however, hold the optimistic view that the devices fill a distinct need in the nation's merchandising structure; they increase total sales of quick-turnover items and reduce overhead costs. On the other hand, they do not compete with personal selling, but supplement it, operating in locations where the use of a sales person would be expensive or impracticable.

This factor is evidenced by figures on the number of different machines in operation at the end of 1941, before the hot-dog and similar units had been developed. At that time there were in use approximately 126,500 cigarette-vending machines and 28,000 beverage-vending machines. Added to these were 250,000 candy-bar units, 3,000,000 penny vending devices, and some 25,000 miscellaneous machines.

For all of these units, durability is a prime requisite. The life of a vending machine is no bed of roses. If a machine is empty or when, on rare occasions, the mechanism jams, it may be subjected to some very rough treatment. Whether it gets off with just a few blows by an angry fist may depend on what other



Peanut dispensing unit uses cellulose-acetate portion wheel; candy displayed in center is protected by acrylic window. Machines must resist hard wear and tear



matic Canteen Company of America. This machine has an electronic cooking mechanism which will heat pre-wrapped sandwiches under the purchaser's watchful eyes, affording hot, nourishing food at the drop of a coin. The focal point of this unit is a chamber in which the sandwich is heated before delivery.

The problem in the construction of this heating chamber was to find material which would have display value and a low power-loss factor at one and the same time. Polystyrene was found to meet both these conditions and has been adopted for the panels in the interior of the display compartment which encloses the sandwich while it is heated. For the same reasons, polystyrene will be employed in

this particular application, and it was slight, was due to a certain amount of brittleness evidenced by the material when used in cold locations.

Low thermal conductivity is responsible for other plastics applications in this field—notably in the Coca-Cola vending machines of the Vendo Company. This quality caused the selection of laminated phenolics for door guides and of molded phenolic material for service door and sill.

Throughout all these units, of course, plastics are used as display and decorative materials—in show windows, name plates, and similar applications.

AUTOMATIC PHONOGRAPHS—It is in the so-called juke boxes that plastics really come into their own as decorative materials. Because of their light weight, they can be used in lavish quantities without increasing the weight of the boxes beyond the point where they can be shipped economically and easily placed on location. In fact, the matter of weight has accounted for quite a number of change-overs from other materials to plastics and from one plastics to another.

This is one of the reasons why the first post-war juke boxes being brought out by the J. P. Seeburg Corporation use cellulose acetate rather than the cast phenolic employed in the company's old machines. When work was started on the new machines the designers decided that by switching to a different type of plastics they could save some of the 20 or 25 pounds that went into the cast phenolic and still have as lavish a color effect.

But in utilizing plastics in automatic record-playing machines, many factors besides appearance must be closely watched. For example, if too much plastics and not enough wood is used in a cabinet, objectionable vibration and noise may result. The sound-deadening properties of wood are vital to the attainment of proper tone quality.

From the standpoint of design, particular care must be taken to ensure that the curves used in plastics panels will not produce serious internal strains in the material. Sharp bends which call for excessive stretching of the sheets in the forming operation result in thin spots and must be avoided.

Fastening the plastics sections in the cabinet requires a method which will assure a close, attractive fit, yet make due allowance for the fact that the machine may be carried on a truck through sub-zero temperatures and abruptly transferred to a

Plastics parts are lighter, reduce shipping weight of automatic phonograph (above) Game machines (right) profit from color and lighting effects possible with plastics



weapons are handy. Hammers, screwdrivers, wires, saws, and other implements may be employed by the disgruntled patron, determined to "get his money's worth."

Investigation of the models now being readied shows a marked increase in the use of plastics, which speaks well for the ruggedness of these materials. Their decorative qualities are important, too, since the machines must catch the eye and do a selling job before the efficiency of their mechanism becomes of any value.

In the past, plastics have been incorporated in vending machines largely for this quality of decoration. The exceptions were in such conventional electrical applications as are to be found in motors, switches, and so on. While this conception of the use of plastics has by no means been abandoned, many of the men who design and build vending machines are discussing that, over and above the mere factor of appearance, plastics can accomplish certain results more satisfactorily than other materials.

This is exemplified by the hot-sandwich dispensing unit soon to be placed on the market by Auto-

matic Canteen Company of America. This machine has an electronic cooking mechanism which will heat pre-wrapped sandwiches under the purchaser's watchful eyes, affording hot, nourishing food at the drop of a coin. The focal point of this unit is a chamber in which the sandwich is heated before delivery.

Another functional use of plastics is to be found in the nut dispenser put out by the same company. Until the war, the portion wheel on this unit was made of aluminum, but when this metal became scarce, a molded cellulose acetate wheel was developed. This part, measuring approximately four inches in diameter and slightly over an inch in thickness, contains four pockets in the outside edge and rotates a quarter-turn each time the machine is operated, delivering the proper portion of nuts. The company reports that the plastics wheels gave satisfactory service, although occasional warpage was experienced and it was necessary to avoid excessively hot water in cleaning them. They met ordinary operating conditions well, but were sometimes subjected to more mechanical damage than the metal parts which they replaced.

To reduce breakage and pilferage from candy-dispensing units, this same company has recently adopted Plexiglas compartment windows. The only difficulty experienced with

heated room. The plastics sections may be fastened to the wooden frame members by means of wood or metal strips, or by drilling the material and screwing it directly to the cabinet, using washers of rubber, fiber, or other resilient materials for vibration insulation and as expansion joints.

Because of their frequent location in taverns and other places where liquor is served, automatic phonographs must be able to withstand occasional accidental spilling of alcoholic drinks. In this respect, many plastics work out quite satisfactorily, not being harmed by the dilute alcoholic solutions encountered. Cigarette burns, another operational hazard, can be sanded out and a smooth finish restored, provided the burns are not too deep.

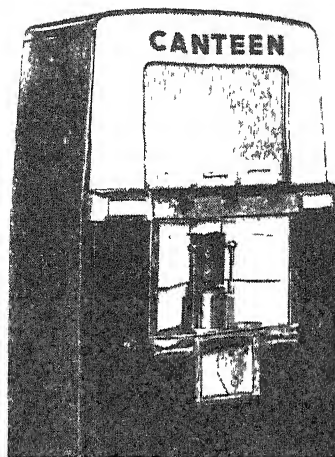
With due allowance for all these conditions, all the leading juke-box manufacturers are increasing their use of plastics in their new models. Seeburg, besides developing cellulose-acetate pilasters to take the place of cast phenolic parts, has worked out red cellulose-acetate sections for the dome ventilator unit on top of the machines, and clear Plexiglas selector bars on which are engraved the numbers of the records.

The Rock-ola Manufacturing Company combines cast resins, cellulose acetate sheet, molded acetate, and extruded acetate in its new units. This company has found the cast phenolic particularly good for their needs because it gives rich illumination effects due to the absence of filler content.

Various plastics for both decorative and functional parts are used by the Rudolph Wurlitzer Company. This manufacturer has found that the dimensional and color stability of acetate under a wide range of conditions make the material particularly good for the pilasters and for internal light shields.

PIN-BALL MACHINES — Problem-child of the slot machine industry, so far as publicity is concerned, is the pin-ball machine. Even more than the vending machine and juke box these devices need bright colors and light for success. And to achieve these ends the makers use plastics.

Since new games must be offered constantly to supplant those in which interest is waning, it was found more practicable to standardize on cabinet sizes, electrical assemblies, and other components, and use the plastics bumpers, islands, and posts to achieve variety. With this arrangement, manufacturers can now change their lines



Polystyrene panels line the cooking compartment of hot-sandwich machine

of games almost overnight by working out new wiring hookups and modifying the mechanical arrangement. Cellulose acetate bumpers, which may consist of from one to several parts, are ideal for this application because they combine ease of molding, resilience, and bright color with translucence, giving the playboard the necessary merchandising punch.

So continues the march of plastics in the coin-in-the-slot field. As engineers and designers gain further knowledge of what plastics have to offer this enterprising industry, even more advanced applications may be expected. And to a large extent this public proving ground of plastics use will open other and even larger fields to these tough, decorative, versatile, and utilitarian materials.



EXPANDED PLASTICS

*Make Attractive
Christmas Baubles*

AN INTERESTING application of cellular plastics, ordinarily used as the core material in plastics-sandwich construction, is in decorative ornaments. One manufacturer, Schwab and Frank, Inc., has brought out expanded-cellular-plastics balls and bells for Christmas decorations. The line may eventually be extended to include a wide variety of decorative ornaments.

PLASTICS CANDIES

*Used as Models for
Shape and Color*

TO CONTROL appearance, an important sales factor in candies, one company producing quantities of multi-colored coated chocolates, has set up a checking system based on a set of plastics replicas of its candies

at every stage in the production cycle.

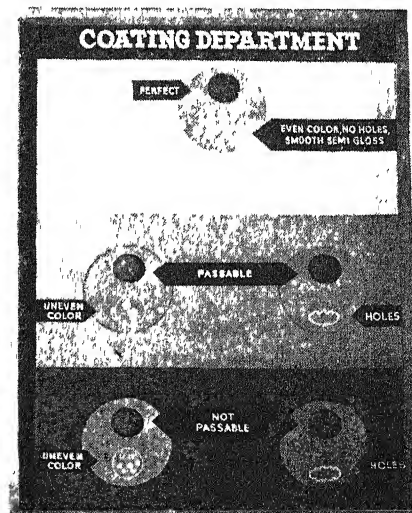
The replicas, cast from an experimental resorcin casting resin developed by Pennsylvania Coal Products Company, are made up exactly to simulate perfect, passable, and non-passable candies at every stage of manufacture. Mounted on colored cards they are used by the inspection staff.

As explained by the candy manufacturers, M and M, Limited, the chocolate centers are automatically squeezed out of multiple orifices in a dropping machine and fall on a moving belt. The chocolate must be of a definite viscosity. If too thin, it falls down; if too thick, the centers will be conical in shape. In either case the pieces will not be usable in the next process. The first two quality-check cards show perfect, passable, and rejected replicas at the center-making stage.

For coating the centers, the operation changes from a continuous one to a batch system in which six different colors are used. Here, the colors of the candy covering must match the standards, and the color must be evenly distributed. Six cards with cast resorcin replicas act as criteria for the six colors.

The plastics were used for these models for several reasons. First, if the candy itself were used on the inspection cards there would be the need of constantly refreshing the models. Trial and error showed that various other materials tried out for the replicas were too subject to temperature and humidity changes. Resorcin, the selected plastics, could be cast in simple plaster-of-Paris molds rather than in expensive, metal molds.

It is suggested that this use of resorcin opens a new field of replica reproduction specially suitable for those with small plastics production facilities and limited capital.



Inspectors match candies to replicas

Diffusion Defeats Drafts

• LOOKING AHEAD •

With the application of skilful air diffusion will come lower industrial heating and cooling costs. . . The end of "cave of the winds" theaters. . . Bus heaters that provide warmth minus blasts of stifling heat. . . Cleaner smelling air, banishment of unventilated pockets in public buildings. . . And cool air in transport planes without disturbing ventilator noises.

FACED with the need for low temperatures in the shipping room, the owners of a dairy plant installed air-conditioning equipment of a modern and highly efficient type. But when the equipment was placed in operation, some unforeseen difficulties arose. The blasts of conditioned air were so severe that employees could not endure room temperatures of 50 degrees, Fahrenheit, although even lower temperatures were required for proper operation.

A thorough investigation of the problem revealed the trouble source to be two ceiling-type unit coolers with horizontal grilles that failed to properly diffuse the rapidly moving discharge air. When changes were made in the air-diffusion system, the troubles were greatly reduced.

Another, and familiar example, of the same air-diffusion problem is the air-conditioned theater. Colds, stiff necks, and general discomfort are frequent by-products of a few hours of entertainment. Here again, otherwise excellent air-conditioning systems receive the blame that actually should be directed to the devices controlling the air at its point of discharge.

In addition to physical discomfort, inefficient air distribution can reflect on the industrial balance sheet as well as on theater box-office receipts. In the case of industry, common colds are responsible for more than one third of the number of work days lost in factories in the United States.

Coolers, Heaters, and Air Ducts are Not the Alpha and Omega of Industrial Air Conditioning. Diffusion—Without Drafts—From the Points of Discharge is Equally Important. Losses through Worker Discomfort and Illness May be Incurred by Overlooking this Function

By LEONARD R. PHILLIPS

Consulting Engineer

Uniform and draft-free distribution of conditioned air appear to be major factors bearing on worker's health and efficiency. Where industrial requirements necessitate forcing cold air directly into the work areas, uneven distribution of temperature and humidity are very likely to result in chilling drafts, cold feet, and similar discomforts

DIFFUSION ESSENTIAL — The problem of achieving comfortable air distribution has been attacked in many ways. Basically, it is important that air-conditioning systems be equipped with air-diffusing units that deliver conditioned air gently so that drafts and stale air-pockets are minimized.

Air, when discharged from a restricted opening, tends to travel in a stream or mass until its velocity energy has been dissipated or overcome by some opposing force. Only after this motion has been expended

does the mass of air mix slowly with the surrounding atmosphere. In order to mix the incoming air readily with room air, it is necessary to create a turbulence that will break up the incoming mass into a multiplicity of smaller masses or streams which can intermingle with other small masses of room air. Moreover, this must be accomplished at the point of discharge of the incoming air.

Ordinarily, grille, register, and louver air-outlet devices employ the pressure principle of discharge. With this system, air is forced through the outlets in unidirectional streams without mixing with smaller masses of room air. Here, little turbulence is created, and the energy of motion must either run itself out, or expend itself on occupants or other obstructions.

In operation, pressure discharge air-outlets do partially separate the incoming air into parallel streams,

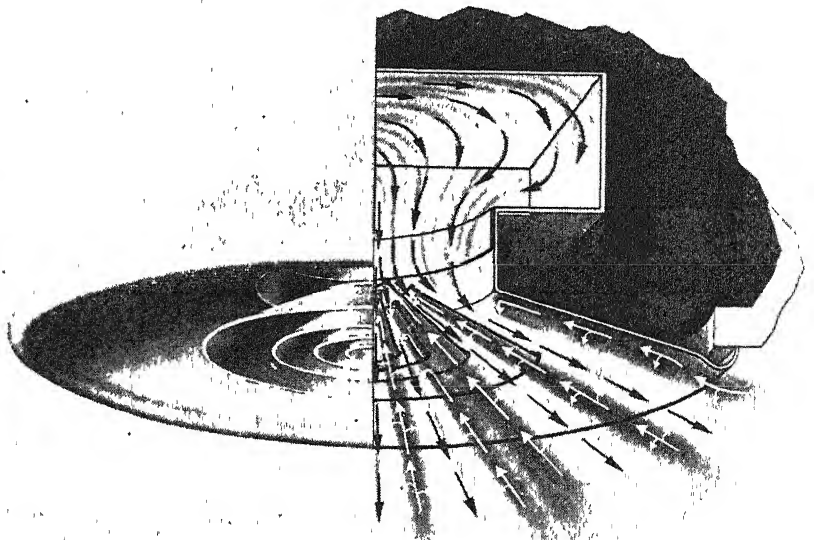


Diagram of Anemostat diffuser—arrows indicate pre-mixing action of counterflow

but each incoming stream draws along a parallel stream of air from that portion of the room air adjacent to it. Generally, these streams adhere to each other, traveling as a single stream, and the diffusion that results with such air supply methods is often inadequate.

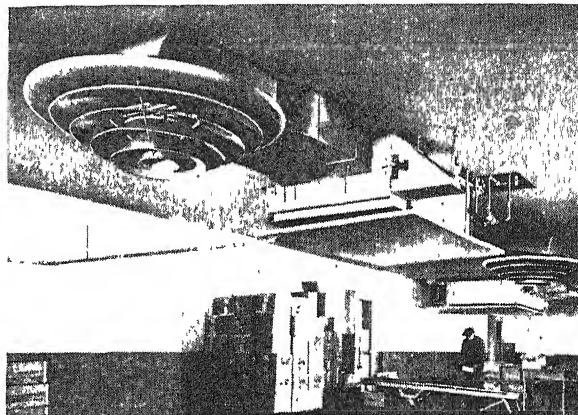
Efforts to prevent the adherence of adjacent air streams and to effect adequate diffusion have shown favorable results from diffusing devices that provide a multiplicity of planes traveling in divergent directions and radiating hemispherically from the device. A diffuser constructed to accomplish this must also create counter-currents, essential to thorough diffusion.

The number of planes into which the incoming air is divided to effect thorough diffusion is largely determined by the volume of air which the device is required to handle. The number of diffusers required in a room is determined by the area of diffusion allotted to each diffuser; and, in turn, this area is determined by the size, shape, and content of the air-conditioned space.

One diffuser based on this concept of air-diffusion is composed of flaring, concentric, metal cones which, although simple in appearance, required considerable research in hydrodynamics and air-flow actions to establish their contours.

REDUCED VELOCITY—When air at duct velocity reaches this device, called an Anemostat, its velocity is immediately reduced by expansion of the air within the flaring cones. This expansion distributes the kinetic energy of the air molecules over

Dairy plant shipping room is example of situation where cold air must be fed directly into work area. Proper air diffusion reduced drafts and increased worker comfort materially.



a wider area, thus converting the velocity energy of the air into a "pressure blanket" on the room air beneath the diffuser.

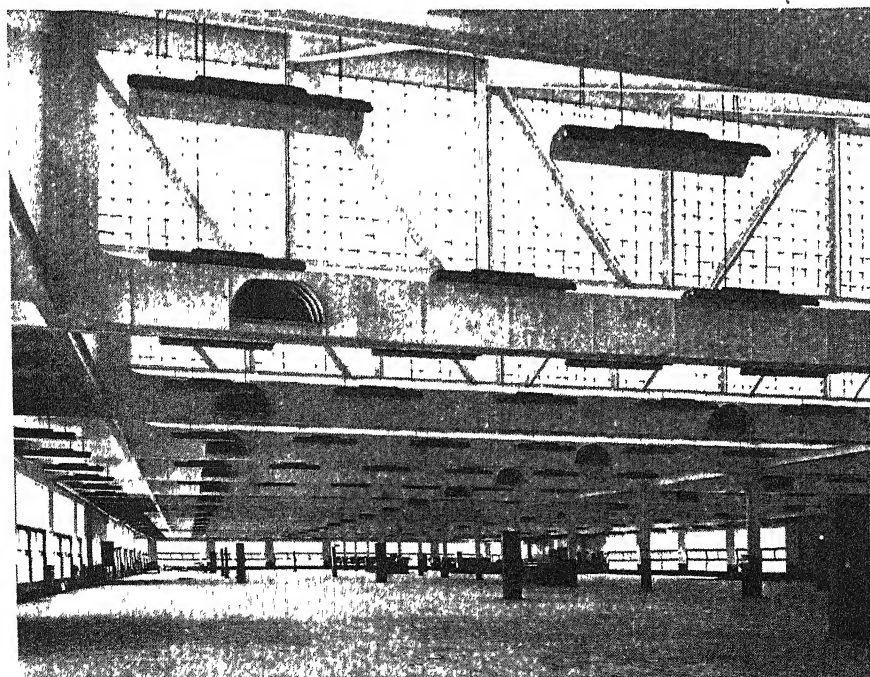
The concentric cones of this diffuser are so formed and fixed that the passage of incoming air through them gives rise to a series of counter-currents of room air back into the cones. These multiple counter-currents carry room air equal to about 35 percent of the incoming air into the diffuser, where it is mixed with the incoming air stream before recirculation.

By these two actions—air expansion and counter-current movement—incoming air is pre-mixed with room air and spread out in the form of multiple pressure blankets on the room air below. This pre-mixed air travels in definite proportions and in all directions away from the air-diffuser. Thus, a hemispherical pattern of slow-moving air blankets is discharged into the room, drafts are greatly reduced, and temperature and humidity approach equalization throughout the room.

In addition, the air-mixing action causes the desired over-all room temperature to be established at a location level well above the breathing level of the occupants. This permits the comfortable use of colder—or warmer—incoming air than would otherwise be possible. And, as an economy factor, the greater temperature differential in turn results in smaller volumes of air requiring conditioning. Hence, plants equipped with efficient air-diffusers may use smaller air-heating and cooling equipment and smaller air-ducts. Moreover, higher duct velocities—which may be employed because of draftless diffusion—result in further reduction of duct sizes and simplification of duct layouts.

PUDDING PROOF — High velocity air-diffusers of the type just described have found wide use under a variety of conditions. The actual number of units involved is estimated to be over 1,000,000. First tried at Madison Square Garden in 1936, the units diffused 400,000 cubic feet per minute of air throughout the stadium in such a manner as to supply 22 cubic feet per minute without drafts to each of the 18,500 spectators. With regard to industrial use, a large number of plants have incorporated high-velocity diffusers in their air-conditioning systems and many have reported measurable increases in the productivity of workers.

Examination of the specific results obtained from these air-diffuser installations reveals something of the performance that may be expected under typical conditions. In one case a two-story reinforced concrete building offered a problem because of substantial heat transfer through glass-block windows and saw-tooth ceiling construction. For comfort, it was necessary to circulate 400,000 cubic feet per minute of air throughout the structure, and 180 air-diffusers were installed to distribute this volume uniformly and without drafts. The air velocities employed vary from 900 to 1500 feet per min-



Saw-tooth roof, large window areas, made air distribution a difficult problem in this building. High-velocity type diffusers equalized temperatures successfully.

ute for the ceiling-type Anemostats, and from 1000 and 1200 feet per minute for the wall-type diffusers installed under the saw-tooth roof. In spite of the high duct velocities, however, velocity readings taken at the breathing level in occupied zones do not exceed 40 feet per minute.

Pneumatically-operated controls regulate temperature and humidity, while the diffusers keep the air uniformly distributed throughout the conditioned areas. In addition, the effects of any delayed action of the thermostatic controls are not so noticeable with well-diffused air, and the absence of drafts and over-cooled or under-cooled spots aids in stabilizing the controls.

TRANSPORTATION USE—Applications of the science of air-diffusion are not, of course, limited to air-conditioned industrial plants and other large buildings. Comfortable air-distribution is equally essential in air-conditioned ships, planes, buses, and railroad trains, and modifications of the basic high-velocity air-diffuser design have been developed for the transportation fields.

Variations in the construction, accessories, and installation of air-diffusers must be engineered to provide air-diffusion patterns matched to the particular type and design of the transportation equipment. To cool or ventilate the many different rooms in a ship, for example, it is

necessary to distribute incoming air in a great variety of patterns. By re-adjusting the geometric relationships between the various cones in the air-diffusers, and in some cases by removing certain cones entirely, draft-free air may be distributed in a way that meets the individual requirements and limitations of berthing spaces, galleys, staterooms, and engine rooms.

In aircraft, likewise, a great variety of air-diffusion patterns are needed to meet the different requirements of passenger quarters, cargo spaces, and flight decks. During the war, many models of military and naval aircraft were equipped with high-velocity air-diffusers, and these units are now being incorporated in new planes of various airlines. Air-conditioned railroad trains and buses were also equipped with air-diffusing units prior to the war, and even more of those now being built will be so equipped.

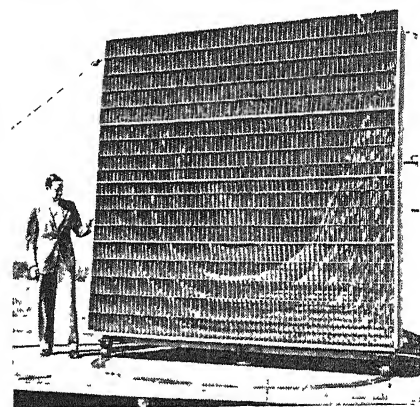
Today, air-conditioning, backed by scientific air-diffusion, makes possible better working and living conditions, new and improved manufacturing processes, and more profitable operations in commercial and industrial enterprises. A better general understanding of the importance of scientific air-diffusion to successful air-conditioning will enable industry to get the most out of investments in such installations.

the parent metal in salt-spray tests. Heliarc welding was developed by Northrop Aircraft, Inc. for use in aircraft production, however, the process now promises to find wide application in other metals-fabricating fields.

LENS ANTENNA

*Beams Radio Microwaves
Between Relay Stations*

A METAL LENS, capable of focusing radio waves as an optical lens focuses light, is expected to find widespread application in micro-



Radio waves change wavefront velocity on passing between metal lens plates

wave radio-relay systems. The relay systems, although designed primarily as adjuncts to telephone networks, will probably find additional use in transmitting pictures, radio broadcasts, and television programs. Aside from its use in such microwave communications systems, the lens also promises to be of value in the development of radar as an aid to sea and air navigation.

A major problem in developing static-free microwave communications has been that of transmitting the wave energy in the form of a narrow beam like that of a searchlight. This requirement stems from the fact that microwaves travel only as far as there is a clear, unobstructed, straight-line path.

Hence, communication over longer distances requires the use of beam-like signals between relay stations so that the total distance is traversed by a series of intermediate transmissions. The new metal lens, which can focus radio waves into the sharpest beam of its kind ever produced, is reported to have solved this problem.

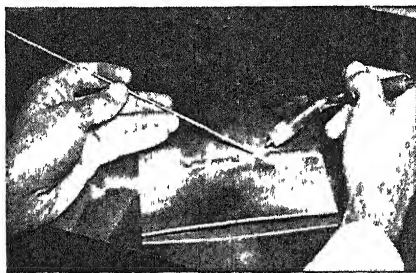
The lens is based on the theory that radio waves undergo a speeding up, or increase in wavefront velocity, when they pass between metal plates, and that the total advance of the wavefront could be fixed by controlling the length and contour of the plates and the dis-

HELIUM-SHIELDED ARC

*Originated for Aircraft Welding,
Now Available for General Use*

HELIARC welding has proved to be a successful medium for working magnesium, stainless steel, brass, inconel, monel, and some of the carbon steel alloys. Research work is now in progress to extend its use to aluminum and to other carbon steel alloys not heretofore Heliarc welded. In the Heliarc welding process, a shield of helium gas envelops the molten metal. Because helium is an inert gas, it prevents oxidation and eliminates the use of a flux and the danger of entrapped flux in the weld ingot that would promote corrosion. The arc in this process is produced directly between a tungsten electrode and the base metal rather than between two tungsten electrodes.

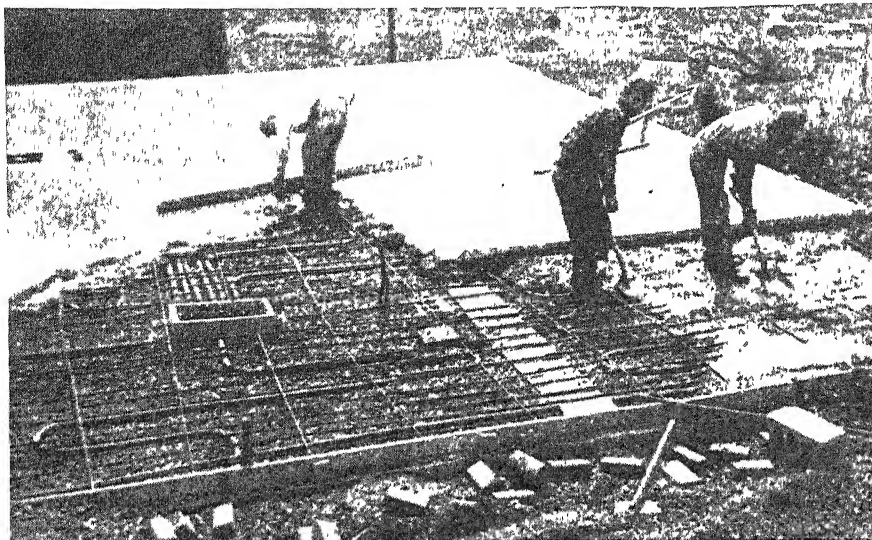
The Heliarc process was first used successfully in 1940. It made possible the use of magnesium, then a new material for aircraft construction. In addition to welding magnesium sheets, extrusions, and tubing into simple, light, and rigid struc-



Ordinary arc burns ragged channel in magnesium (left). Helium-protected arc (right) forms smooth, even bead

tures, the Heliarc torch may be used to repair magnesium castings containing foundry defects with welds equal to or stronger than the surrounding metal. The weld metal is described as much denser than the surrounding cast metal and less susceptible to corrosion. It is said that almost any thickness of cast metal that can be poured may be readily welded with this process.

Welding rod of the same alloy as the parent metal is usually used for castings and wrought alloys. The weld ingot appears to have better corrosion-resistance properties than



tance between them. The necessary design theory was worked out in mathematical detail at the Bell Telephone Laboratories and systems of metal plates were subsequently built to duplicate the action not only of convex and concave lens but also of other optical devices, such as half- and quarter-wave plates and prisms. In addition, the new lens is more rugged than the delicate parabolic reflectors formerly used.

RADIANT HEATING

Proves Well-Adapted to Single Story Residences

A HOUSING DEVELOPMENT, now nearing completion, features radiant-heating systems supplied with hot water from gas-fired boilers in each house. It is claimed that this type of heating will eliminate any danger of damp, cold floors that might be encountered in basementless houses.

Radiant heating, unlike other heating systems, is based upon the principle of controlling normal body heat losses by warming surrounding cooler surfaces. Thus, comfortable conditions are obtained with lower air temperatures than those found in conventionally heated structures.

Since the homes are of the "utility type," space utilization is an important consideration. With the wrought-iron radiant heating pipes concealed in the floor, virtually every inch of floor space is available for use and the floor is kept uniformly warm. Sinuous coils of the 1¼ inches radiant heating pipes were fabricated at the site of each house by the contractor, Frank Corace. Cold bending was accomplished by means of an electrical-hydraulic portable bending device shown at the right above.

When the coils had been positioned on the gravel fill, welded together, and tested under 250 pounds

Heating pipes, layed before slab is poured (above), keep floor warm, dry, and save space. Portable bending unit (right) speeds fabrication on the job

pressure, the 5 inch reinforced concrete floor slab was poured. For finish flooring, mastic asphalt tile was used.

Hot water for the radiant heating system is circulated through the coils by a small pump, and each house system contains about 55 gallons of water. The pump action is controlled by an ordinary wall thermostat. An aquastat regulates water temperature. Balance cocks for supply mains to individual rooms are centrally located in a pit with a removable plate in the utility room. Once the cocks have been adjusted according to the desired conditions of comfort in each room, they need not be touched during the entire heating season.

STATIC ELIMINATOR

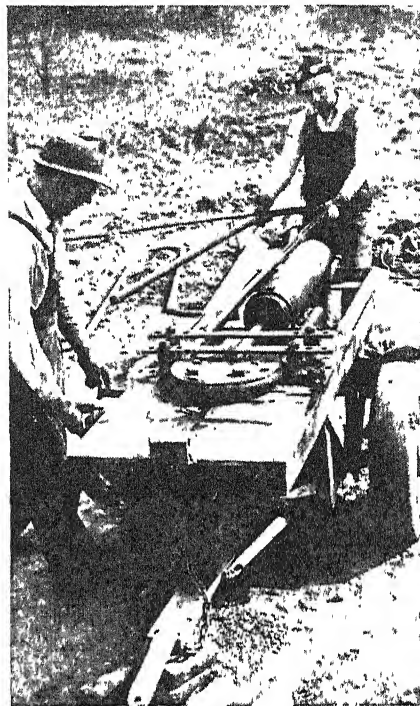
Provides Conducting Path of Alpha Rays

STATIC electricity is removed from industrial machines and processes, where it constitutes a fire hazard and complicates production, by a new method developed by United States Radium Corporation. The method utilizes a radioactive source of alpha rays, located near the points where the static charge tends to build up. This ionizes the air, so that it carries off the static electricity, eliminating the possibility of sparks or cohesion. The unit, known as the Ionotron static eliminator, is self contained and has no electrical connections or moving parts.

Moving, non-conductive materials, like paper, cellophane, rayon, and nylon yarns create and store static electricity at points where there is friction, such as where paper leaves a roll, or a belt leaves a pulley. This

is the same static which causes a comb to give off sparks on cold, dry days. In many industrial processes, static constitutes a serious problem, for the sparks it generates can ignite inflammable gases and liquids. In addition, static-charged sheets of paper and cellophane tend to stick together and curl. This slows up production.

Alpha rays emitted by a radioactive unit surface in the Ionotron ionize the surrounding air. Ionized



air is a conductor of static electricity, and serves as an invisible "wire" over which trouble-making static flows and is carried harmlessly away to ground.

The Ionotron static eliminator consists of a specially designed housing strip containing radioactive foil, which emits alpha rays, in a controlled direction. No changes in machine design are needed, nor are special precautions required to safeguard operating personnel. Service is no problem, as there are no moving parts, and half of the potency in the foil will remain after 1600 years of service.

HOPPER CAR

Holds More, Weighs Less; Built of Welded Steel

REDUCTION of dead weight and increase of capacity, without sacrifice of durability, are basic ideas behind the construction of a new all-welded steel hopper car. The car weighs 6540 pounds less, and will hold that much more coal, than the standard hopper car.

In general, the new car does not differ radically from the dimensions

of the conventional hopper. A smooth interior surface, resulting from the elimination of protruding structural members and seam ledges, permits a free flow of material during unloading, and prevents accumulations of moisture and dirt where corrosion may start. The car is built of Cor-Ten, a high-strength, low-alloy steel, described by the United States Steel Corporation as corrosion resistant.

MOON RADIO

May Answer Television and H-F Communication Problems

RADIO TRANSMISSION between two points on the earth after reflection from the moon may enter the realm of practicality, according to engineers of the Federal Telecommunication Laboratories who have been engaged in an analysis of this project for some years. Now that it has been publicly demonstrated by radar that the space surrounding the earth is not impassable to radio waves, a consideration of this subject appears pertinent in view of developments that may not be far in the future.

The ionosphere, the currently utilized reflecting medium for long-range, high-frequency radio transmission, is held to consist of various layers of ionized upper air, 60 to 250 miles from the earth's surface, which reflect the radio waves. This reflection enables the signals to be received at points located far beyond the horizon and over the curvature of the earth—often half-way around the globe. Certain disadvantages, however, are presented by the behavior of radio waves on contact with this reflecting medium, notably that waves of the higher frequencies are not reflected but penetrate the ionosphere. This prohibits long range transmission in the upper ranges of the frequency spectrum.

For long-distance radio, transmitted in the higher frequencies, it now seems possible to use the moon as a reflecting medium. The fundamental principle of this transmission would be the same as that of the Signal Corps moon-radar experiments. In these, an ultra-high-frequency pulse was beamed at the moon from an antenna somewhat similar to that used for radar airplane detection, and the answering echo was received at the same point. Since the reflected waves radiate from the moon's surface in a wide angle, it is apparent that the receiver could be located at a distance from the transmitter—in fact, any place on the earth where the moon could be "seen" at the same time

as at the transmitter. By setting up a transmitter and receiver at New York and Paris, for example, two-way communication could be established between the two stations.

It is said to be possible to send radio telegraph or facsimile communication over such a set-up. Both the transmitting and receiving antennas would have to be directionally oriented toward the moon, and would have to maintain their orientation as the earth revolves. This, however, is a mechanical problem which can readily be solved by a clockwork mechanism similar to, but simpler than, that used by astronomers to keep telescopes trained on a celestial body.

The advantages of moon-reflected transmission would include the known, desirable characteristics of very-high-frequency transmission, plus allowing for a considerable number of channels. At present the useful band width is narrow, thereby limiting the transmission to code messages, but it is probable that future developments will overcome this disadvantage, when higher power transmitters become physically and economically feasible.

A further advantage of the system, since the radio waves strike the receiver from above, would be freedom from interference by natural obstacles between the transmitter and receiver. Hence the blocking action of the earth's curvature, mountains, cities, and other obstacles to high-frequency line-of-sight transmission would be eliminated, and nation-wide television

broadcasts from a central station might become practical. Elaborate receiving stations, if necessary, could pick up the program as reflected from the moon and re-broadcast it to the home receivers within their effective radius. This arrangement would eliminate the necessity of an expensive and elaborate network of line-of-sight repeater stations to reach out-of-the-way locations.

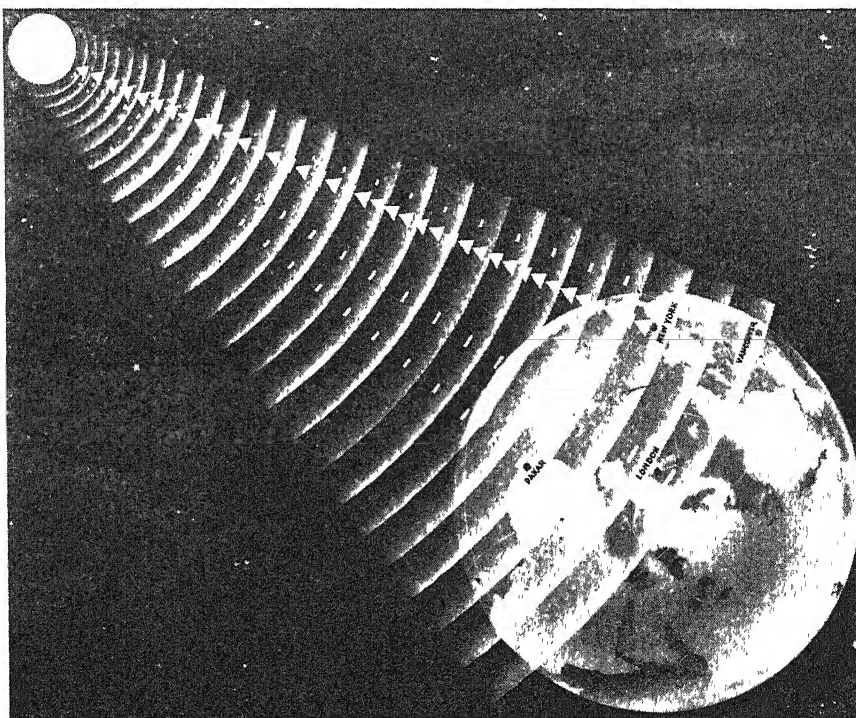
BARNACLES BAFFLED

By Plastics Paint on Ships' Hulls

HOT PLASTICS paint, at temperatures of 300 degrees, Fahrenheit, is being used by the Navy in a spraying operation on ships' hulls. The plastics paint forms a "skin" which minimizes barnacle growth and is a war-time development that increased the effective range of vessels in tropical waters.

The hot plastics paint is delivered by a synthetic-rubber hose with Fiberglas reinforcing. This combination, selected because of its high tensile strength and heat-resisting qualities needed to withstand the operating pressures and temperatures encountered, was developed by the DeVilbiss Company.

Hot plastics paint on hulls is reported to double the time a ship can stay out of dry dock between barnacle-removal jobs and still operate efficiently. With spray painting equipment using the new hose, a crew of 140 men can apply the hot paint to an entire battleship hull in 16 hours.



Radio-echo principle could eliminate interference from mountains and buildings, would allow widely spaced global stations to receive broadcasts from New York

New Products and Processes

TOOL TIPS

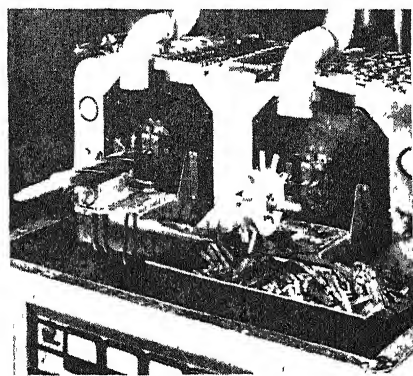
*Brazed Rapidly and at
Low Cost by Induction Heat*

IN THE practice of brazing tungsten-carbide tips to cutting tools, a recently devised application of induction heating is reported to have brought about greatly increased output with no increase in manpower. One factor in the new method is a rotary fixture which enables one operator to do in an hour what formerly was achieved in approximately eight. These operations are being performed on two 15 kilowatt, two-station, 9600-cycle units of standard Ohio Crankshaft-Tocco Process make, equipped with water-cooled inductor coils. With two stations each, the self-contained induction-heating units, 48 by 32 inches in base dimensions, are located in the production area of the shop.

Compared to other methods used to braze tips, The Willey's Carbide Tool Company reports that the cost-cutting advantages of induction treatment include: no need for removal of excess metal from the shank of the tool; elimination of wiring tip to shank; reduced wear on the finish grinding wheels by elimination of the wiring on tip; cooler and cleaner operation; more positive, uniform type of braze; and limiting of rejects to a fraction of one percent.

When using this system, the tip and brazing material are positioned in the recess, then the tool is placed beneath the inductor. The heating cycle may run from three seconds upwards to a minute depending upon the type of tool being brazed. As the heating progresses, a small rod is used to "wipe" the tip into place as the material softens. Cycles can be controlled automatically or manually.

The rotary fixture which helped increase production is a transite block six



Methods of holding tools while being tungsten-carbide tipped in an induction furnace include a rotary fixture (right) and a magnetic check (left)

inches in diameter, mounted on a revolving spindle. The block has a capacity upwards of 20 tools ranging in size from $\frac{1}{4}$ to $\frac{3}{4}$ inch square and of moderate length. The tools are held in the fixture by spring tension and as the operator manually rotates the block the tool enters the field of the inductor coil where it becomes heated. When the short cycle concludes, the tool is moved to the vertical. Here, it releases automatically from the fixture and drops into a box or onto a conveyor below.

MODIFIED THERMOPLASTIC

*Shows Improved Properties,
For Higher-Temperature Use*

A THERMOPLASTIC injection-molding powder, a modified polystyrene, is intended for use at temperatures above the heat distortion point of unmodified styrene compounds or of Plexiglas, the acrylic plastics made by Rohm and Haas Company. Claimed superior in weathering properties and in resistance to chemicals, the material, known as Plexene M, also has improved machining qualities. Moldings made with the new material are reported not to show any tendency to the crazing characteristic of many unmodified styrene compounds.

In molding, Plexene M requires slightly higher cylinder temperatures than styrene formulations and best results are obtained in the 430 to 480 degrees, Fahrenheit, range using medium to high molding pressures. Residual strains are lessened by its flow characteristics. Although shrinkage is affected by molding conditions, size and shape of part, and other factors, Plexene M moldings are said to show very low shrinkage even for "heat resistant" thermoplastics.

Described by the makers as odorless and tasteless, the company is practically unaffected by acids, alkali, and dilute alcohol, and is resistant to gasoline and commercial inks. It is attacked, however, by organic solvents such as acetone and ethylene dichloride. The natural color of Plexene M is a light amber, and translucent and opaque colors ranging from ivory to black are available.

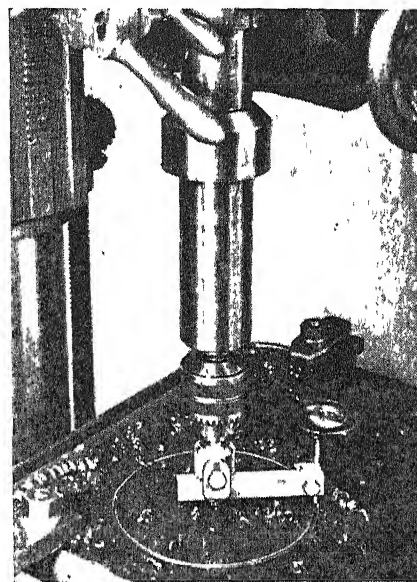
CIRCLE CUTTER

*Adjusts Easily to
Accurate Diameters*

SMOOTH, large-size holes in wood, steel, brass, hard rubber, aluminum, fiber, plastics, and other materials may be quickly cut with a new tool. Called the Bruno Adjustable Circle Cutter the device cuts holes to any diameter from $1\frac{1}{8}$ to 8 inches through $\frac{1}{4}$ inch thick-

ness in steel or other tough metals, and any thickness up to $1\frac{1}{2}$ inches in plastics, fiber, or wood. Thickness capacities may be doubled if cut is taken from both sides of material. The tools are designed to operate in any standard drill press, wood-working machine, or suitably mounted spindle machine.

The circle cutter is said to be designed on a new principle which permits easy, yet accurate adjustment. It consists of a combination drill and pilot with a high-speed cutting blade, adjustable to depth and diameter. A "Wedge-lok" cutting-blade holder per-



Cuts clean holes in many materials

mits the cutting edge to recede or yield from work while still maintaining steady pressure and feed. The cutting blade is re-sharpened without special tools by grinding on one edge only. The twin-blade holder—fixed $\frac{1}{2}$ inch center—cuts washers, wheels, disks, and gaskets in one operation.

SALTS IN OIL

*Removed by Washing
and Glass Fiber Treatment*

PROGRESS in the development of a new process for removing from crude oils the inorganic salts that have a corrosive effect upon refining equipment was recently described at a meeting of the American Institute of Chemical Engineers.

Essentially, the process consists of washing the crude oil with water at a temperature in excess of 250 degrees, Fahrenheit; passing the oil and water through beds of fine glass fibers to coalesce the emulsified water; and separating the de-salted oil from the aqueous phase.

The glass fibers employed have an average diameter of 28 one-hundred-thousandths of an inch, and provide 1079 square feet of surface area per pound of glass. The water phase is recycled to conserve heat. Only sufficient fresh water is used to maintain the salt content of the recycled water at a maximum of 3 percent by weight.

It has been found, according to the paper on the subject, that salt con-

tent can be reduced to less than five pounds per 1000 barrels of oil by proper control of temperature, superficial velocity, density of the Fiberglas beds, and total depth of the beds. Temperature of at least 275 degrees, Fahrenheit, gave the best results.

ANTI-FOAM AGENT

Reduces Foaming During Industrial Processing

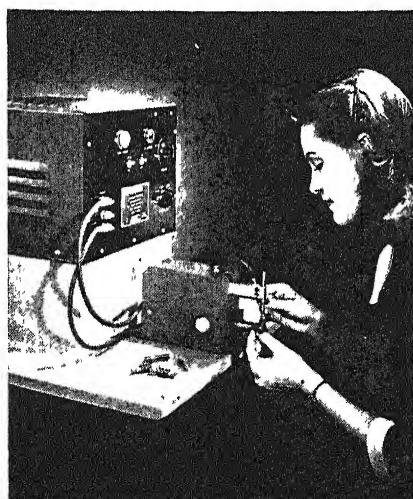
CHEMICAL processes and industrial operations, particularly when aqueous alkaline solutions are used, are often handicapped by severe foaming. Now a new silicone compound, DC Antifoam A, has been developed especially for use against foam in such solutions and emulsions.

Tests indicate that the anti-foam agent eliminates or reduces the foaming of various aqueous solutions even when they are subjected to steam distillation or vacuum concentration. It also appears that the material is effective in very low concentrations, ranging from a maximum of one part per 10,000 against strong foamers to one part in a million against weak foamers. The manufacturer, Dow Corning Corporation, states that the ability of DC Antifoam A to reduce foaming in any specific material can be established only by testing it in various concentrations in the solutions that are to be defoamed.

MINIATURE WELDER

Brings Precision Control to Small-Weld Operations

ELECTRONICALLY - controlled welding equipment that does away with the human element of control of the quality of the weld is now available in the low-price field. A miniature welder,



Capable of 120 welds per minute, unit operates on standard 60-cycle current

capable of high-performance welding on diversified types of metals—those required in radio tube construction, for example—is said to offer precise values of welding pressure and energy.

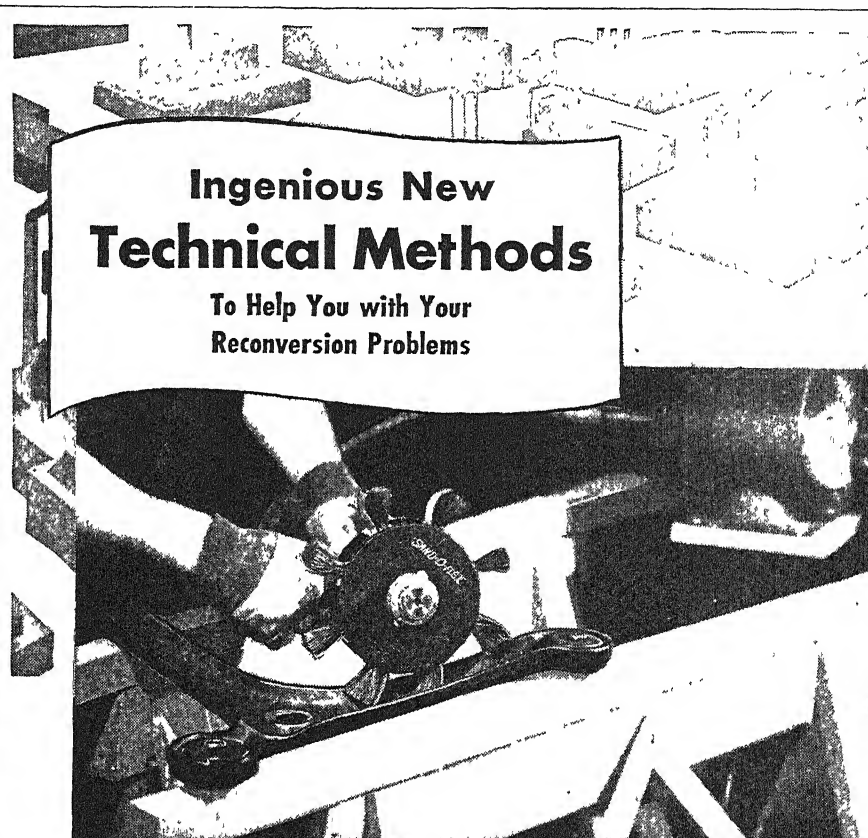
The unit is small, measuring 9¾ inches high, 13 inches wide, and 13½ inches long, and can produce 60 to 120 welds per minute on a total thick-

ness of .035 inch for practically all metals and principal alloys, or on combined pieces being welded of .060 to .070 inch in cross-wire welding. The instrument plugs into a standard 110-125 volt, 60-cycle power line. Current draw averages three amperes at maximum setting.

Called the Raytheon Miniature Weld Power Unit, the device allows the power output into the weld to be varied. A voltage-adjustment control varying the capacitor-charging voltage from 750 to 1500 volts and a three-position capacitor switch by which values of 14, 28, or 56 microfarads can be attained, are mounted on the front panel of the control unit. Having once been adjusted for a given power and time cycle for a certain material and

thickness, the miniature unit requires no further adjustment to produce constant uniform welds. The materials to be welded are placed between the electrodes and the energy stored in the electric storage system is applied to the pieces to produce a weld.

The welding head of the unit is designed to give a pre-set pressure to the material being welded, and when the pressure is applied the power is triggered by a micro-switch mechanism located in the head, thereby controlling the applied pressure and cycling of the weld power. Metals that may be welded by the device include iron, aluminum, copper and copper alloys, nickel flat and wire, nickel alloys, tantalum, platinum sheet or wire, tungsten sheet or wire, gold sheet or



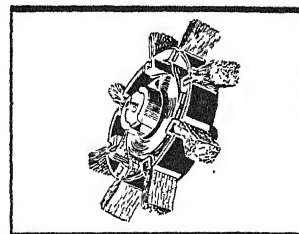
New Brush-Backed, Strip-Fed Abrasive Wheel Deburr's, Sands Any Surface!

For sanding in and around the most irregular contours—for deburring parts too large to be tumbled—for removing rust, paint and imperfections from wood, plastics, rubber, earthenware and metals—the new Sand-O-Flex brush-backed abrasive wheel is MOST PRACTICAL.

The central magazine houses a strip abrasive cartridge, to be fed out as needed in front of the eight brushes which "cushion" the abrasive, and force it evenly over the most difficult surfaces. The Sand-O-Flex comes in 3 sizes, and is adaptable to any stationary or portable motor shaft, with speeds up to 1750 RPM. Abrasives are available in grits for every need.

To help speed production in dry, dusty work atmosphere, many mills and factories urge workers to chew gum to help relieve dry throat. *The reason:* Because dust causes throat irritation and dryness—but chewing Wrigley's Spearmint gum helps keep workers' mouths moist and fresh. *The result:* Reduced work interruptions and "time outs" to the drinking fountain. Even when workers' hands are busy, they can refresh as they work "on the job." And the chewing action helps keep workers alert and wide-awake.

You can get complete information from the Sand-O-Flex Corporation, 4373 Melrose Ave., Los Angeles 27, California



Abrasive Cartridge Shown Open



AA-73

wire, constantan sheet or wire, stainless steel, and alloys of the above materials.

The electronically-controlled unit is expected to find many applications in the manufacture of small jewelry, electrical equipment, electro-chemical apparatus, and radio parts

NO-STARCH TEXTILES

*Produced by Treatment
With Resins*

CRISPNESS in cotton fabrics, without the use of starch, is now possible with a resin textile finish for application at the time of manufacture. Garments will be bought with the resin already applied. It is said that despite repeated launderings and dry cleanings, the finish will not wash out of the fabric but will remain to restore its newness and crispness after each washing and ironing.

Called Kandar, the United States Rubber Company's treatment can also be used on rayon fabrics to give them better drape and fullness. A rayon blouse or dress will drape, shirr, or gather better because of the new treatment.

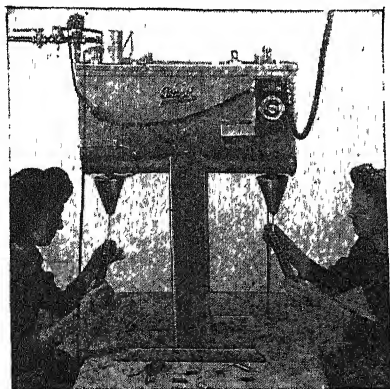
HOT TANK

*Melts Insulating Compound;
Supplies Two Operators*

FOR HEATING, melting, and pouring battery, transformer, capacitor, and resistor compounds, a new gas fired, electrically controlled, and fully insulated, production tank is available. The unit, known as Model 22TGT and made by Aeroil Products Company, is heated from the inside through a removable immersion-tube system. This method of heating, plus full insulation, is claimed to bring the user a substantial saving in time, labor, and fuel.

A novel feature of the tank is that it is equipped with two outlet valves that are separately heated. Since the outlet valves are at opposite ends of the tank, two operators can work independently with both hands of both workers free. The distance across the table between the valves is 21 inches, leaving room to set up cooling racks or other production aids. The ends of the valve are 15 inches above the table level, thus giving ample clear working space.

While the tank itself is gas fired, it is



Outlet valves are separately heated

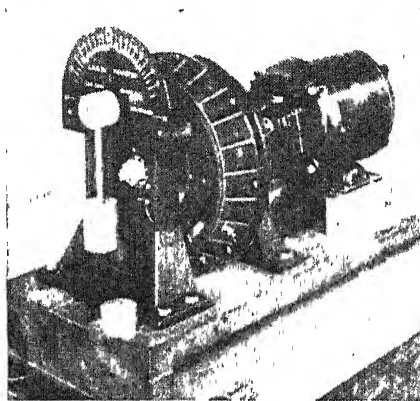
equipped with electrically-operated thermostatic controls for temperature regulation from 100 to 550 degrees, Fahrenheit. A dial thermometer is installed in each unit for visible temperature check. In addition, each heating tank incorporates a safety pilot control to shut off the gas line should the pilot light be extinguished.

Instantaneous flow control is claimed by the manufacturer because of the gravity-type, poppet-acting valves together with strainer and heat-baffle plates to give added assurance against freezing or clogging. The full liquid capacity of the new tank is 10 gallons but other sizes are planned.

MOTOR POWER

*Measured Conveniently
with Small Dynamometers*

FOR QUICKLY measuring torque and horsepower of fractional-horsepower motors, including flea-power, dynamometers of the eddy-current type



Suitable for continuous-duty testing

with D.C. excitation are now offered as more accurate and convenient than prony brakes. Torque loads are varied by rheostat adjustment.

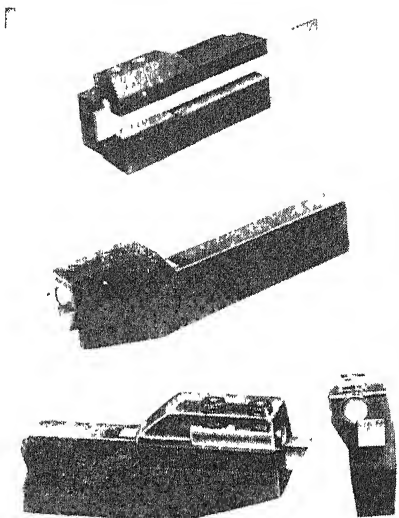
Said to save time in both laboratory and production use because they are self-damping and self-cooling, the Absorption Dynamometers are described by the L. A. B. Corporation as permitting one-man operation. Reported as meeting the need for continuous service units, they are intended for speedy production set ups for testing electric, hydraulic, pneumatic or internal-combustion motors, and flexible shaft transmissions.

Either running or stalled torques may be measured; no springs or frictional devices are used. The smallest sizes measure torques at speeds up to 15,000 revolutions per minute and up to 10 ounce inches. Other sizes measure up to 25 inch pounds.

LATHE TOOLS

*Gripped Firmly
with Solid Support*

DROP-FORGED lathe turning and cut-off tool holders, embodying a feature for holding the cutting bit rigidly in place, were recently announced by The Cooper-Bessemer Corporation. The new turning-tool holders are forged from a special analysis steel and in-



Cut-off tool and turning tool (above) are secured in holder by clamping pin visible in lower phantom view. Long gripping area gives better dissipation of heat, helps resist side pressures

corporate a clamping pin which engages the bit for nearly its entire length.

Two flush-type set screws are said to lock the tool bit into position with a vise-like grip and prevent any possible slippage. According to the manufacturer, the turning-tool holders have a number of advantages including better dissipation of heat, use of short bits, reduced chattering and less bit breakage, and convenient tool adjustment features.

Similar advantages are reported for the new cut-off tool holders. These securely grip the cut-off blade vertically by a clamping pin at the top which is accurately machined to a V-groove at the bottom. The clamping pin engages a considerable portion of the blade, holding it to a true cutting position, it is claimed, regardless of side pressure imposed on the blade.

DRAWER-TYPE OVEN

*Utilizes Space Efficiently,
Regulates Temperature Accurately*

INCREASING oven capacity without increasing floor space is a possibility featured by the manufacturer of a drawer-type oven. Offered as proof is the experience of a paint brush manufacturer who is reported to have gained 2½ times more oven capacity—for vulcanizing brushes—with this type oven. The reason for this, according to the Despatch Oven Company, was that there was less waste space inside of the oven and with a new type of heat-distributing and air-circulating system the interior work space could be utilized to the maximum for production.

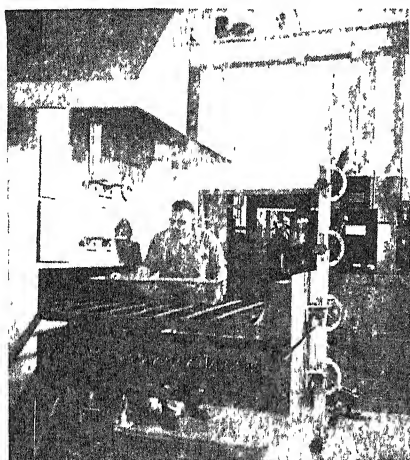
In addition, the drawer-type oven eased loading the paint brushes because they could be handled in pans. The oven has five drawers, each one 4 feet wide by 6 feet long by 8 inches high, which provides sufficient loading capacity for approximately 1800 pounds of paint brushes per charge. An overhead loading mechanism makes it possible to withdraw one or more drawers at one time, thereby meeting the load-

ing and unloading conditions as necessary

It was said that the new oven showed a heat uniformity within the working area of plus or minus 2½ degrees, Fahrenheit. The temperature range is from 125 to 350 degrees. An automatic temperature-control instrument provides automatic regulation of the oven at the temperature desired and a Partlow recording instrument provides a constant record of the operation.

The ovens have an approved safety system manufactured by the Brown Instrument Company that automatically shuts down the oven in event of gas, or power, or fan failure. There is also a special high limit cut-out thermostat so that if the temperature exceeds the desired setting by more than 10 degrees the system is automatically shut off.

The Despatch direct gas-fired heater



Oven drawers are conveniently loaded

is mounted on top of the oven to conserve floor space. It has a rating of 150,000 British thermal units per hour and is of the atmospheric type with a "Controlled Combustion" feature which is claimed to assure high operating efficiency under all conditions.

LEAK-PROOF BOTTLES

*Retain Corrosives Even
When Shattered*

TOUGH, nitrocellulose-plastics coated bottles in which corrosive liquids can be shipped or stored without danger of the liquid leaking out if the bottle is broken, are now available. The coating provides a protective armor around the bottle and holds its shape even though the glass underneath is shattered.

In tests, when bottles containing acid were thrown against a metal wall with sufficient force to break all the glass, the coating retained its shape and prevented the acid from seeping through. Other advantages of the coating are transparency and colorability with dyes for identification purposes, plus protection of the label on the bottle. Also, the bottles can be washed without affecting the qualities of the coating.

Developed by the Detroit Macoid Corporation, the coated bottles are expected to find wide acceptance for use in laboratories and plants where cor-



Six Tu-way EXACT
WEIGHT Scales check-
weighing "Aunt Ellen's"
PI-DO packages in Dallas,
Texas

Packaging "Aunt Ellen's" famous PI-DO . . .

A delicious, crispy pie crust mix in 8 oz. packages . . . "Aunt Ellen's" famous PI-DO. Good Ingredients are uniformly mixed and blended for the housewife. No hit or miss packaging here either. Every package is checked on Tu-way EXACT WEIGHT Scales for accurate weights for the consumer and profitable operation for the processor. This is a good example of a difficult packaging operation in mass production. Our engineers will be glad to advise you on how to best solve your food handling problems too from start to finish.



65 West Fifth Ave., Columbus 8, Ohio

Dept. Ad. 873 Yonge St., Toronto, Canada

rosive liquids are used and stored as well as for shipping these liquids. In manufacture, the bottles are dipped into a solution based on a Hercules Powder Company nitrocellulose. When the excess plastics has dripped off, an even film of from 20 to 25 thousandths of an inch remains on the bottle.

ANTI-RUST FILM

*Adheres to Metal
During Forming Operations*

PROTECTION of metal during manufacturing stages, a tighter bond with paints, and longer life through enhanced corrosion resistance, are advantages claimed for a new rust-proofing technique for steel and gal-

vanized steel. Basis of the method, called the Banox process, is a flexible, glassy, metal-phosphate coating, that will bend with the steel or even permit die-stamping without harm to the coating. The coating, which has a thickness of from 5 to 15 millionths of an inch, may be put on by the spray, immersion, or brush methods and requires no heat.

According to the developer, Calgon, Inc., the treatment prevents rusting between cleaning and painting; insures a grease-free and alkali-free surface for maximum adherence and flexibility of organic finishes; increases the durability of the finish as measured by outdoor exposure, salt-spray, "sweat-box" humidity, and water immersion tests; and prevents spread of

rust from unprotected edges, scratches and other areas where the basis metal is exposed. Applications of the process are expected in automotive, domestic appliance, and other lines where high quality finishes are important.

FIRST-AID HEAT

*Immediately Available from
Self-Contained Device*

RAPID and safe, an emergency source of heat for medical use employs no liquids of any kind. Called the Redi-Heat Block, the unit is entirely self-contained and always ready for use, requiring about one minute to reach top heat. Wrapped in a towel or blanket, the block maintains its temperature for approximately one hour, and furnishes safe heat for emergency treatment of victims of shock or other injury.

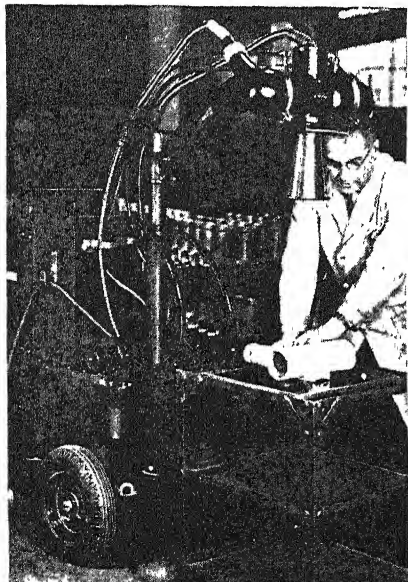
Made by Mine Safety Appliances Company, the heater consists essentially of a block of light-weight metal with high heat-transfer value, encased in a cover and containing a replaceable charge. The Redi-Heat Charge is a small, sealed metal cylinder containing a chemical compound. The charge is inserted in the block, where it is activated by raising and releasing a spring-loaded lever—thus starting a chemical reaction which evolves safe, dry heat.

Weighing 22 ounces and measuring 3½ by 4 by 1½ inches, the device fits conveniently into industrial first-aid kits, cabinets, dispensaries, and field station units. It is impervious to heat, cold, and moisture and is said to store indefinitely without deterioration.

RESIN OIL LINE

*Resists Deterioration, Carries
Coolant to X-ray Anodes*

IN COOLING the anodes of modern X-ray machines, hose assemblies must resist oil, heat, and pressure. A new polyvinyl resin product is reported to provide a resilient oil-impervious conduit that solves the problem satisfac-



Long life and no internal sloughing are advantages of resin coolant hose

torily for all types of oil-cooled machines. Called "compar" tubing and developed by Resistoflex Corporation, the tubes carry the oil which flows over the anodes of the machine to carry away the heat.

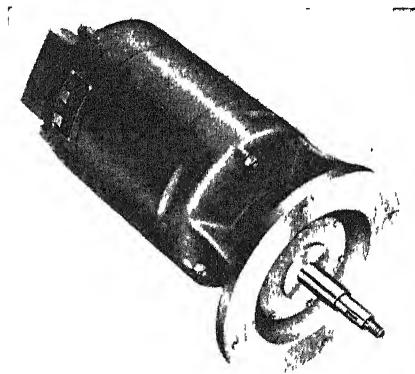
The imperviousness of the compar core of the tubing to the effects of the hot oil circulated at varying pressures is said to permit almost unlimited service life. Flexibility and resiliency remain constant throughout the lifetime of the tubing and in addition the compar is described as offering complete freedom from sloughing or rotting. Thus there are no particles dislodged from the tubing to contaminate the system or to clog intricate parts.

COMPACT MOTOR

*Gives High Speeds
on Standard Power*

A GEAR-MOTOR for industrial electrical equipment delivers five horsepower at 8000 revolutions per minute, using commercial 3-phase, 60-cycle, 220-volt power.

Designed for limited-space applications, the motor is a fan-cooled, open-



Gears provide unusual output speeds

type, two-pole 3600-revolutions per minute unit, with output speed stepped up to 8000 revolutions per minute by single-reduction helical gears in a sealed gear box. Smaller, lighter, and more compact than the conventional ungeared motor, the same Electrical Engineering and Manufacturing Corporation design, with changed gear specifications, will fit a variety of applications requiring output speeds not ordinarily obtainable with commercial current.

PLASTICS PRESS

*Speeds Pre-Forming of
High-Bulk Products*

PRODUCTION time for heavy-duty plastics products is promised to be markedly reduced as a result of a new semi-automatic pre-forming press that will permit high-bulk phenolic materials, previously pre-formed by hand, to be pre-formed into units weighing as much as one pound.

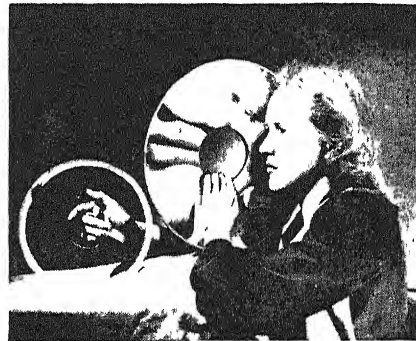
Also, the new press allows material to be dielectrically pre-heated, a treatment that cannot satisfactorily be applied to non-formed compound and is reported to reduce the molding cycle

considerably on most applications. Another feature of the General Electric press is the safety factor effected by external loading of the machine.

TELEVISION LENS

*Combines with Mirror
To Enlarge and Sharpen Images*

LARGER, clearer television pictures from home television receiving sets are said to be possible with a new image-



Lens-mirror combination for television receivers. The mirror (center) distorts the image; the Schmidt lens (left) corrects the mirror aberrations

correcting glass lens. Described as the heart of a television receiver's optical system, the new lens, with wave-like curves, corrects aberrations caused by projecting television tube images on a reflecting mirror used in the optical system to enlarge the images. A reflecting glass mirror, as a companion piece to the correcting lens, provides a combination that permits screen images five times larger than the pre-war variety.

Made by the American Optical Company of a durable, stable glass, the image-correcting lens will retain its optical properties during the entire lifetime of a television receiver. The lenses are claimed to be more than 10 times as fast as an f/2 camera lens.

Prior to the war, according to American Optical, there were fewer than 50 lenses of this Schmidt correcting type in the world, and these were used in high-speed astronomical photography. Days, weeks, and sometimes months were required by a skilled lens grinder to make one by hand, whereas the new correcting lens can now be produced in quantity in a few hours by a new production method.

In manufacture, the wave-like curves of the correcting lens are produced by heating a flat piece of glass until it flows into the specially curved surface of a refractory on which the glass is placed. The refractory serves as a mold in some respects and is made of a special composition that does not adhere to the glass. The lens is then ground and polished to a sparkling finish.

A television optical system, using the correcting lens-mirror, receives television images from the receiver's cathode-ray tube, projects them on the special mirror, then reflects the image through the correcting lens onto a flat mirror which in turn reflects the focused picture on the viewing screen. Larger, clearer television pictures re-

sult. For example, a cathode-ray tube only five inches in diameter produces an image which fills a screen 18 by 24 inches.

HALF-CAR LOADS

*Handled Conveniently by
Aluminum Freight Holder*

MADE from strong aluminum, a new light-weight freight container has a capacity equal to half of a box car. Weighing less than a ton, the container, 20 feet long, eight feet wide, and eight feet high, is especially designed for truck-trailer transportation of general merchandise between loading docks and railroad flat cars. Easy shifting from truck to train is aided by built-in hydraulic jacks and ball-bearing rollers.

High corrosion-resistance, according to Reynolds Metals Company, helps cut maintenance costs, insures longer and trouble-free life. As a compact container, the unit also lends itself readily to water and air transit. Used with a delivery service similar to those now in existence, the unit would make possible door-to-door delivery on one-half box car shipments with no intermediate handling of the contents required.

Besides use for shipment of general merchandise, the Reynolds unit has been designed also as a refrigerator container and can. Through controlled refrigeration, it maintains zero temperature for 36 hours without re-icing.

SPHERICAL BEARING

*Solves Load-Speed-
Temperature Problems*

CAPABLE of carrying heavier loads at higher speeds and lower temperatures, a new-type spherical roller thrust bearing is expected to facilitate wind-tunnel operation for research into such aeronautical projects as gas turbine and jet propulsion speeds and designs. It also promises to ease maintenance and operating problems on large vertical water pumps, electric generators, and other high-speed machines. It is explained by SKF Industries, Inc., that the design solves long-standing problems in the bearing field.

Other applications have been suggested as thrust blocks on marine propeller shafts, on roll necks in steel and aluminum rolling mills, and as thrust mountings for railroad turntables, water turbines, water wheels, oil well swivels, dredge pumps, extrusion machinery for plastics and rubber, and various types of gear drives. Ability of the new bearing to carry heavy loads at high speeds is possible because of an unusual design which permits more effective lubrication.

PHONO PICK-UP

*Couples Amplifier More
Closely to Record*

AN "ARMORED VACUUM" tube in the tip of a phonograph tone arm gives direct-action translation of mechanical sound

from the record into electronic modulations. Featuring simplicity, and capable of reproducing the full beauty of recorded music including delicate tones, the new pick-up resists abuse and is claimed incapable of damaging records.

Operation of the device, as described by the manufacturer, Bendix Aviation Corporation, depends on transmission of the mechanical undulations from the record groove by a filament which introduces them directly into the electron stream within the new vacuum tube. The entire pick-up occurs within a small fraction of an inch. By this means many intervening steps are eliminated together with the danger of

loss of fidelity, trouble possibilities, and increased cost of manufacture.

Temperature and humidity proof, climatic conditions do not limit use of the pick-up, nor does it deteriorate from disuse or require any special protective measures to insure its operation.

Record wear is said to be eliminated by the fact that less than two-thirds of an ounce of pressure is exerted on the record. The tone arm is designed to the "minimum tracking error," permitting the contact point to follow faithfully each record groove, even through the heaviest bass passages. When necessary, the entire reproducing element may be replaced by simply

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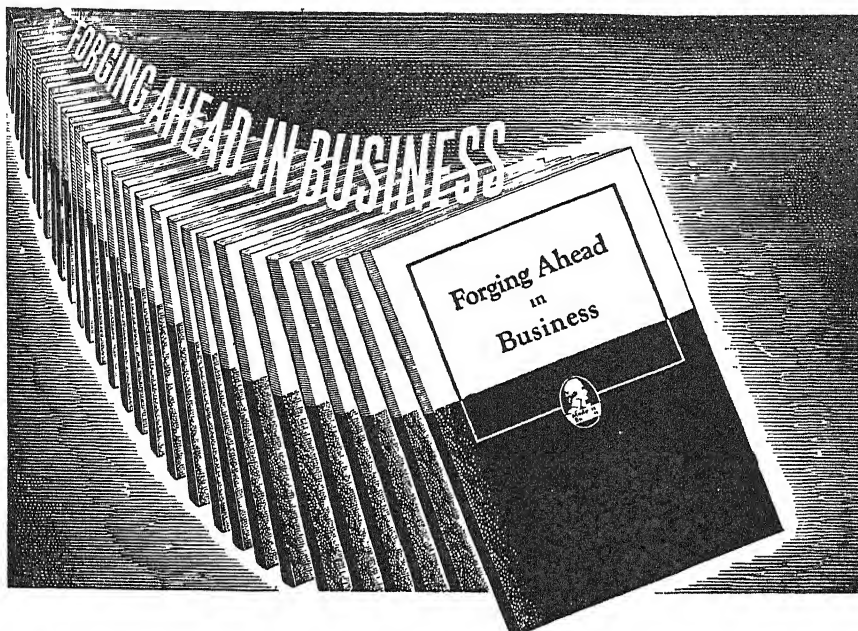
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6158-S*	18	80	\$1.00
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6164-S*	26	104	.80
6166-S	29	54	1.25
6168-S	29	76	1.25
6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	63	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25
6182-S	27	51	1.25
6183-S	44	189	2.50

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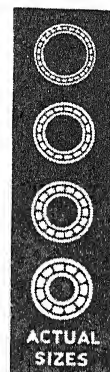
plugging in a new tube, and since the pick-up contains all of the elements necessary to translate mechanical vibrations into electrical energy, replacement restores the unit's full capacities

ANTI-FRICTION BEARINGS

Meet Precision Needs
in Small Sizes

MINIATURE ball bearings, designed for use in small motors, computers, electronic equipment, drive movements of recording devices, testing and laboratory equipment, and other precision

Advantages of anti-friction bearings in locations where space is restricted can be realized with small, light precision units

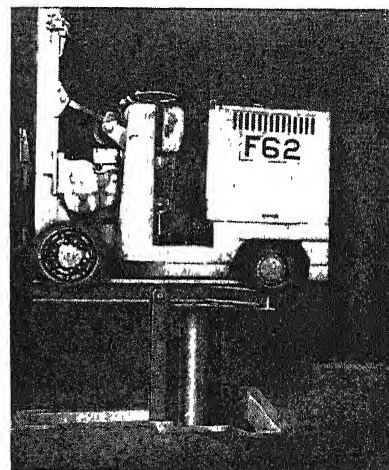


mechanisms, are now available to meet the needs for anti-friction bearings in restricted locations. Supplied with an outside diameter of 5/16 inch and bores of 7/32, 3/16, 5/32, and 1/8, the bearings are manufactured of chrome bearing steel and finished to precision tolerances. As described by their maker, Miniature Precision Bearings, the bearings will accept unusually heavy loads and high speeds for their size and weight.

OIL LIFT

Raises Industrial Trucks
for In-Plant Service

FOR SERVICING power trucks within a factory one manufacturer uses a hydraulic lift equipped with a platform consisting of one longitudinal and a transverse beam. Tops of these beams are flush with the floor when elevator is not in use, a sump pit being provided for this purpose. A power truck to be serviced is driven over the



Power truck lifted for servicing

hoist so that the rear axle comes to rest directly over the transverse H-beam. By means of adjustable axle blocks, two under the front axle and one under the rear axle, the power truck is held in position on the elevator with its wheels turning free when the elevator is raised to servicing position.

A steel safety guard drops to vertical position when the elevator is raised, the bottom of the guard resting on the bottom of the sump pit. This guard must be folded along side of the H-beam when the elevator is lowered.

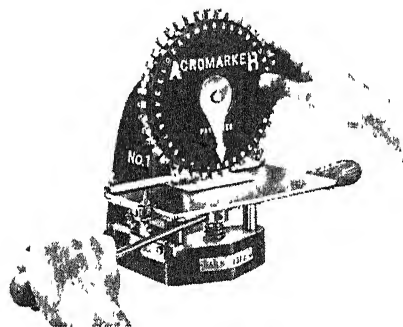
Said to be safer than other arrangements, the Revolverator elevator is raised by forcing oil under pressure into the ram, the same oil cushioning the load when lowered. A lever operated against spring pressure controls the operation both up and down.

STAMPED LETTERS

Easily Impressed in Stainless Steel with Five-Ton Squeeze

AN IMPROVED thread in the heavy "pressure applying screw" of a name-plate and parts stamping machine is claimed to give sufficient power to stamp letters, figures, and other characters into stainless steel to required depth in sizes from 1/16 to 3/16 inch.

When stamping polished stainless steel surfaces, the impressed characters



Pressure screw assures deep stamping

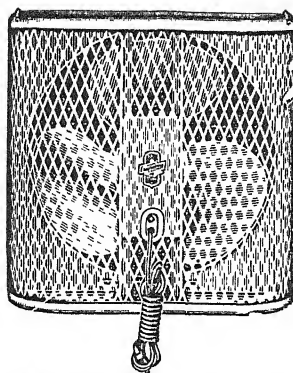
require enamel or other filling for maximum legibility and the deeper stamping permits easy filling of all characters.

Efficiency of operation is claimed to have been engineered in this improved machine, called Model No. 1 Acromarker, in that the right hand may be used to turn the index wheel, while an easy left-to-right swing of the operating lever applies pressure estimated at over five tons. This powerful screw pressure is sufficient to sink the individual characters into low-hardness, heat-treated alloy tool steels, iron and beryllium castings, as well as the stainless and chrome-plated steels used for name plates and machine parts.

WINDOW FAN

Quickly Installed; Gives Large Volume Circulation

RAPID air circulation in small homes, apartments, tourist courts, small stores, shops, offices, and so on is provided by a new 20-inch cooler fan, for window



3500 cubic feet of air per minute

installation, that will exhaust 3500 cubic feet of air per minute, in free air.

Modern in design and finished in ivory enamel to harmonize with modern home furnishings, the fan, according to the Emerson Electric Manufacturing Company, is easily and quickly installed. The latter operation requires only putting two screw eyes in the window jamb, setting the fan on the window sill and raising the window. Plugged into a convenience outlet, the fan is ready for use.

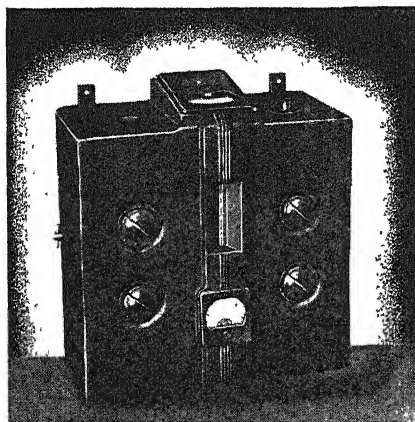
Features include a capacitor motor for quiet, economical operation; blades formed from sheet aluminum for large volume air delivery and quiet performance; and minimum maintenance. Cabinet dimensions are 24 inches square by 9 inches deep, suitable for mounting in any window with a minimum opening of 20 inches square.

GAS IMPURITIES

Detected by Precious-Metal Catalyst

BOTH OXYGEN and hydrogen impurities in gases may be detected and measured with a new dual-sensitive instrument known as the Deoxo Indicator. This device uses a precious-metal catalyst for measuring the presence of oxygen or hydrogen in inert gases—nitrogen, carbon dioxide, and saturated hydrocarbon gases. When required, the indicator can be furnished with a circular-chart type potentiometer-recorder and air-operated controller.

Ruggedly constructed and capable of operation for long periods with little or no attention, the instrument is stated by Baker and Company, Inc., manufac-



Contaminated-gas indicator



THOUGHTS HAVE WINGS

You Can Influence Others With Your Thinking

TRY IT SOME TIME. Concentrate intently upon another person seated in a room with you, without his noticing it. Observe him gradually become restless and finally turn and look in your direction. Simple—yet it is a *positive demonstration* that thought generates a mental energy which can be projected from your mind to the consciousness of another. Do you realize how much of your success and happiness in life depend upon your influencing others? Is it not important to you to have others understand your point of view—to be receptive to your proposals?

How many times have you wished there were some way you could impress another favorably—*get across to him or her your ideas*? That thoughts can be transmitted received, and understood by others is *now* scientifically demonstrable.

This FREE Book Points the Way

The tales of miraculous accomplishments of mind by the ancients are now known to be fact—not fable. The method whereby these things can be **INTENTIONALLY**, not accidentally, accomplished has been a secret long cherished by the Rosicrucians—one of the schools of ancient wisdom existing throughout the world. Write for the free copy of the fascinating sealed book, "THE MASTERY OF LIFE," which explains how you may receive this unique wisdom and benefit by its application. Address. Scribe E.K.C.

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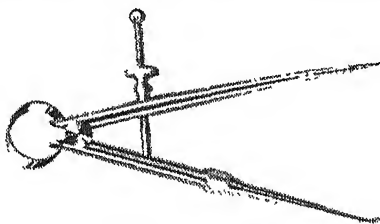
turers, to be suited for both industrial and laboratory use. It indicates the presence of from .001 percent to 1.0 percent oxygen impurities, and tests have shown that the accuracy of indication may be estimated at plus or minus 2 percent of the range in use at any time.

In industry the indicator promises to be useful in many ways. It will check losses resulting from large batches of a product spoiled by traces of oxygen in sintering atmospheres, and it will also help to avoid costly spoilage by detecting and measuring any oxygen impurity in the gases used for filling tubes and lamps. The company's literature states, "Minute quantities of oxygen in the atmosphere of heat-treating and brazing furnaces may result in impaired quality, especially when working with stainless and other alloy steels."

CALIPER

Features Rigidity and Precise Adjustment

A TOOLMAKER'S hermaphrodite caliper with round legs, a stiff spring, and a tapered fit between the spool and the legs, is reported to have improved rigidity and other advantages over conventional flat-leg calipers. Precise adjustment is made with the adjusting



For precision work

nut and screw. As described by Nork Products Company, its manufacturer, one leg is reversible by loosening the firm-grip chuck, and the scribing point is easily replaced. Both four and six inch models are available.

CASTING RESIN

Solves Air-Bubble Problem in Complex Moulds

A WATER-LIKE synthetic resin has been developed to eliminate the air bubbles that have often made the production of complex plastics casts extremely difficult. The new version of Plastitool resin, according to Duorite Plastic Industries, cannot retain air bubbles because its low viscosity enables the force of gravity to draw the liquid resin down into a homogeneous mass within a mold.

When completed, the casts are described as having essentially the same strength properties as those made with more viscous resins.

TOOL BITS

Shear Metal; Use Same Grind for Various Materials

SAID to utilize the principle of molecular cleavage, a pre-sharpened tool bit cuts metal with a knife-like action. Standard in size, the new tool embodies

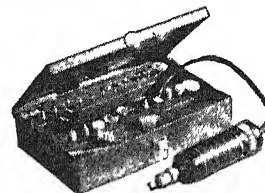
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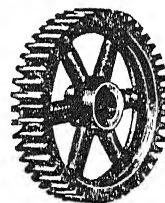
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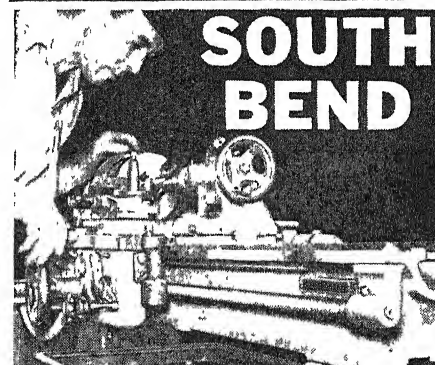
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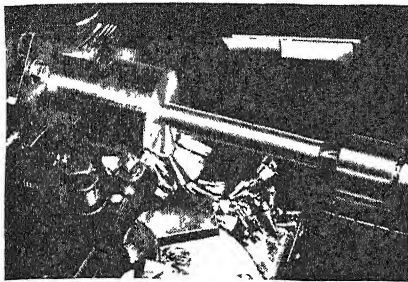
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Pre-sharpened bit takes deep cut

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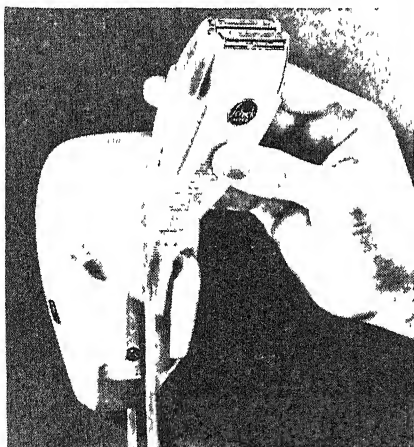
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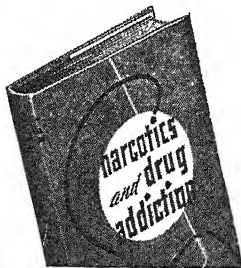
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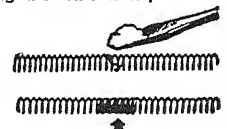
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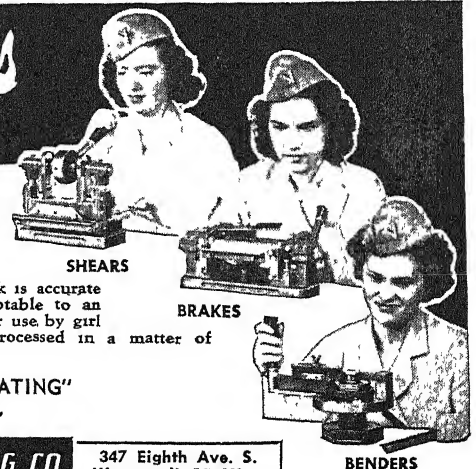
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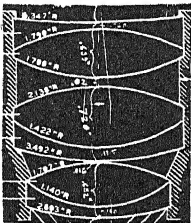
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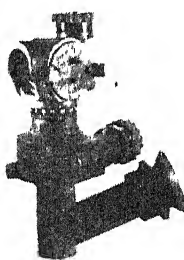


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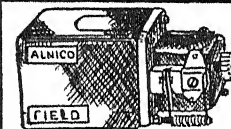
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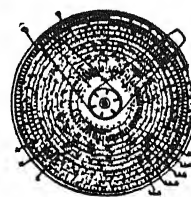
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CYRIL G. WATES, Edmonton, Alberta, Canada, before his recent lamented death, wrote the description which follows:

"In 'A.T.M.' page 275, F. J. Sellers describes a simple drive for small telescopes, which is based upon the principle of a weight to perform the work, and a clock to control the speed. Several years ago H. Boyd Brydon, of Victoria, B.C., a member of the Royal Astronomical Society of Canada, greatly developed Sellers' drive, improved it to the point where it has become an ideal drive for the amateur of limited means and average mechanical talents, and described it in Volume 37 of the Society's *Journal*.

"The Brydon drive (Figure 1) involves the use of two worms engaging with a single worm gear, a principle which is believed to be completely new, despite Solomon's dictum to the contrary. In the drawing the drive has been cut down to the barest essentials, omitting such features as idlers, hand control and so on, which may be devised by the builder to suit his own tastes. The drawing shows the view straight down the polar axis, to which is secured the large wheel W. A length of braided brass (or steel) picture wire is secured at P to the roller R, around which it is wrapped five times, thence passing twice around W, again five times around R, but in the reverse direction, finally passing under the pulley to which is suspended the weight.

"R is free to turn on its shaft, except for the friction of the spring-operated clutch. With the clutch out of engagement, the weight would turn the telescope from east to west. On the roller shaft is the worm A1, engaging with the worm gear G, which may be of any convenient size. Disregarding for the moment the second worm, A2, it will be seen that the weight will turn the roller R, which in turn will drive the worm A1 and the gear G. However, the second worm A2 locks the Gear G and prevents any of the parts from moving under the influence of the weight. Nevertheless, the telescope may be moved freely in right ascension by hand, since the clutch will slip and the roller turn without affecting the worms or the worm gear.

"The shaft to which A2 is secured is attached in turn to the winding key of an ordinary alarm clock. In most such clocks the key makes one turn in six hours. Therefore, if the roller R is made exactly one fourth the diameter of the wheel W, the telescope will move at the rate of one revolution in 24 hours. The clock is, of course, ad-

justed to keep speeded sidereal time.

"Important features of the Brydon drive are the fact that the clock does no work whatever and that the smoothness of motion is independent of the accuracy or fit of the gears, since the weight automatically takes up all lost motion. In the original design, connection between the worm A2 and the clock is by means of a simple jaw clutch fitting over the key, but we venture to suggest that A2 be secured to its shaft by a lock nut. The right-hand end of the shaft may then be permanently attached to the clock by threading or, better still, by means of a simple universal joint. The clock may be wound at any time by loosening the lock nut and turning the shaft by a suitable key.

"As stated, the drawing is diagrammatic. In the complete drive the cords cross below W, pass over idlers and thence to the roller, which is only a few inches wide instead of extending right across the diameter of W."

When replying to a question put to him by this department, Brydon commented as follows on his drive: "You might suggest the desirability of fitting a pawl to prevent the wheel between the two worms from turning backward, or trying to, and thereby putting an enormous end thrust on the worm attached to the clock. This happened in one instance I think the trouble was

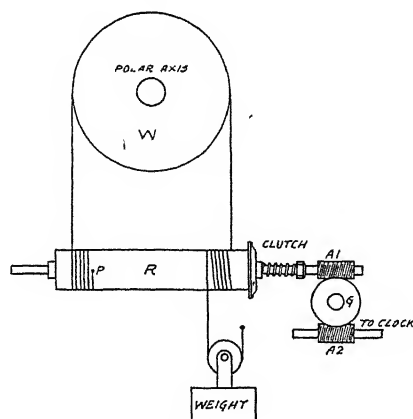


Figure 1: The Brydon drive

too great friction in the friction plates. It can happen when the telescope is turned back toward the east, and a pawl is a safety factor."

LEO J. SCANLON of Valley View Observatory, 106 Van Buren Ave., Pittsburgh 14, Pa., writes: "I've recently had occasion to make some four-bar spiders and have devised an adjustment feature for secondary mir-

ror supports which I've never seen before. It works fine and has provision for centering the diagonal in the tube and a tilting arrangement that's simplicity itself. For the parts I went to the bathroom."

The sketch, Figure 2, is almost self-explanatory. The four fins of the diagonal support are attached to a piece of $\frac{3}{4}$ " brass pipe 2" long. Within this is a length of $\frac{1}{4}$ " thread rod (from closet tank float ball). It is held by two brass dome nuts (used to hold closet bowl down to floor) tightened against two 1" iron washers. These are

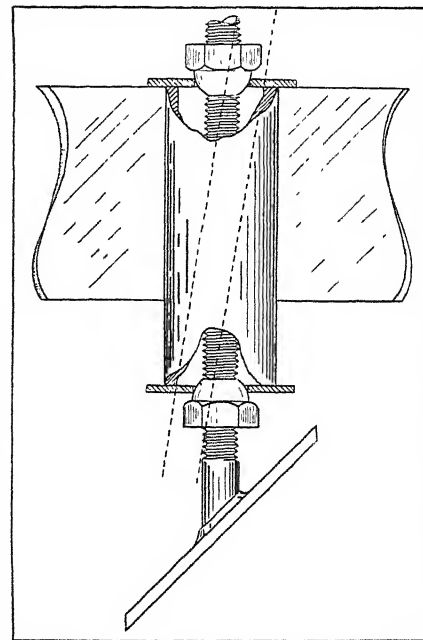


Figure 2: The bathroom secondary

not attached to the brass pipe but held there by tension and friction alone.

The dotted line indicates extreme adjustment possible. Shifting the washers laterally permits tilting the diagonal (if the shifts are opposite) or centering it in the tube. The nuts afford a longitudinal adjustment in the tube, and the diagonal may be rotated.

SILVERED MIRRORS are believed to be largely extinct—but how largely? There is an Old Guard who stick to straight razors, stiff collars, shirt tails worn inside, and silver coatings, and continue to swear by them all. In "A.T.M.," page 102, Ellison tells how silvered mirrors may be protected from tarnishing, by means of a loose pad of blotting paper. F. J. Hargreaves of England has an even better method. He cuts out a disk of $\frac{3}{4}$ " corkboard, dishes it to the mirror's curvature, shellacs it and allows the shellac to dry. Then he cuts out an equal circle of wash leather (chamois skin), lays it on this disk, temporarily lays a piece of clean paper over it, and through this he presses it on the shellac with a hot iron.

He finds that, unless the chamois is everywhere in firm contact with the silver, the latter will tarnish, also that this contact does no harm to the silver.

As a check test, he removed a central circle from the chamois, choosing the

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area that lay behind the diagonal of the telescope, and watched the gradual effect. That patch later showed up as a round "tonsure" Tarnish.

Chamois skin is hygroscopic—thirsty—not alone when on the mirror but when off during observation, and therefore must not be given a drink by being left in the open during those intervals.

EVERY YEAR Westinghouse systematically searches out native talent in science among high school seniors the nation over and awards 40 scholarships, two for \$2400, eight for \$400, and 30 for \$100, at colleges of winners' choice. This year by written competition Westinghouse boiled down some 16,000 applicants to 40 finalists and brought the 40 to Washington, D. C. for further boiling and entertainment.

This department was agreeably surprised, yet not surprised, to find among the 40 a keen youth with whom it had exchanged letters on things telescopic—Kenneth Widing, 611 N Fifth St., Brainerd, Minn. When Widing reached Washington he too was agreeably surprised to find that, of the 40 telescope making finalists present, six were amateur telescope makers and a seventh, a young lady, had started telescope making when given a refractor. Of the seven TNs, three won \$400 scholarships and four won \$100 scholarships; but after Westinghouse puts a finger on this promising material, various colleges usually volunteer additional offers.

Some time ago with the (easy) catalytic help of this department, three wartime Roof Prism Gang "alumni," learning that polio had left Widing one-armed, laid an RFT on his doorstep. English of St. Paul dug up a spherical mirror, Broadhead of Wells-ville, N. Y., parabolized it, and Johns of Larchmont, N. Y., using long probes in his shop for the search, located an RFT mounting under nine strata of post-Paleolithic telescopic accumulations such as you, too, probably have.

Telford of Florida has helped Widing with advice on a fairly good mirror of f/8 type which he has made one-handed, but the mounting proves to be more of a problem, a sketched-up affair. Who will send this lad a good mounting for that general-purpose type of telescope? For insight, try putting it in shape with one hand behind you. There must be scads of them lying unused, supplanted by newer jobs.

Asked what originally aroused his scientific bent, as revealed by Westinghouse, Widing replied: "Telescope making was my source-inspiration and I'm a TN for keeps."

TOUCHING a point hinted at above is an appeal from Professor Charles H. Smiley of the Department of Astronomy at Brown University, Providence, R. I., president of the American Association of Variable Star Observers, who seeks recruits for this application of telescopes made by amateurs. He writes:

"What becomes of all the telescopes made by amateurs? Ingalls has said

this question is as difficult to answer as that better-known question, 'What becomes of all the pins?' In an effort to determine whether possibly some of the telescope makers eventually use their telescopes for regular observations, I wrote ten letters to members of the American Association of Variable Star Observers reputed to have made telescopes. The replies told me of ten members who, together, have made 33 telescopes. In addition, these persons have suggested 14 more telescope makers in the organization.

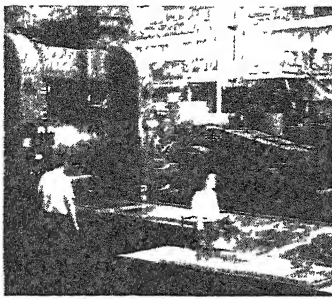
"In the following list of the ten mentioned I include only the largest telescope made by each, with apertures and focal lengths rounded off to the nearest inch.

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F. E. Ellis, Cambridge, Mass. 11" f/7.6
W. S. Houston, Moundsville, Ala. 10" f/8.6
R. W. Hamilton, Norwalk, Conn. 10" f/6.7
S. F. Thorpe, Louisville, Ky. 10" f/5.4
Miss Martha E. Stahr, Wellesley College, Wellesley, Mass. 8" f/6.4
E. A. Sill, Mamaroneck, N. Y. 7" f/14
R. A. Seely, New York, N. Y. 6" f/10
S. Park, Fall River, Mass. 6" f/7
F. J. Kelly, Fall River, Mass. 6"

"The A.A.V.S.O.," Prof. Smiley continues, "is an organization having 290 members in the United States and 16 in foreign countries. They observe regularly the magnitudes of stars known to be variable in brightness, and periodically report to the Recorder, Mr. Leon Campbell, at Harvard College Observatory. In the near future, the combined members will have completed their millionth observation. Performing well a task which would otherwise fall upon professional astronomers, these amateurs are providing the basic material on which important researches on variable stars will be made in the coming decades. Persons who think they may have some talent for the observation of variable stars may obtain information concerning the A.A.V.S.O. from Mr. Campbell at Harvard College Observatory."

STELLAFANE CONVENTION of amateur astronomers, telescope makers, and of telescopes, will be held this year on Saturday and Sunday, August 3-4. The evidence is that this time more of all three categories will hit the Stellafane trail a resounding whack than ever before, and if you are not bringing a tent or otherwise sure of accommodations, reserve them before July 1. Try Hartness House or Adnabrown Hotel, both Springfield, or Windham Hotel, Bellows Falls or Fullerton Inn, Chester—all Vt.

Porter expects to come east for the meeting—has done nothing but write about it for months. (He has also been told that a D.Sc. degree is to be conferred on him but not at Stellafane, so when you see him there he'll be Doctor Porter but still the same Porter.) Bring your telescopes; everybody else does.



INDUSTRIAL DRAMA: Magnesium, available in unlimited quantities from the sea, may someday occupy the place among metals that is now held by iron and steel. Why and how this may come about will be found in the article starting on page 53. Our cover photograph shows the rolling of magnesium sheet in a plant of Revere Copper and Brass Incorporated.

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AUGUST 1946 • SCIENTIFIC AMERICAN

50 Years Ago in . . .



(Condensed from Issues of August, 1896)

STILL NOT METRIC — "The arguments in favor of the metric system for England are equally strong, or soon will be, as applied to the United States; for although our foreign trade does not approach the volume of British foreign trade, it is likely that in the course of time it will do so, and even exceed it. Prudence would suggest that we should avoid the dilemma in which the English manufacturers find themselves, by making an early change to the metric system. . . Any temporary inconvenience which might be experienced in making the change would be amply compensated by the subsequent saving in time and trouble."

ROTATING SHAFTS — "Some of the results arrived at by recent tests made at the Watertown Arsenal are regarded as of special importance in relation to the endurance of rotating shafts. While it has been found that great improvements in tensile strength and elastic limit have been obtained, it has not been shown whether the limit of endurance under repeated strains has been increased. In the rotating tests of cylindrical shafts, alternate tensile and compressive strains are successively applied, and under these conditions of loading no steel has yet been experimented with which will endure a continuous fiber stress of 40,000 pounds per square inch without rupturing."

SPECTROGRAPHIC ANALYSIS — "W. N. Hartley has determined the composition of a coin by an ingenious adaptation of the methods of spectrographic analysis. The spectrum of the coin was photographed and the metals present first ascertained, after which their relative proportions were arrived at by comparing the photograph with a series of quantitative spectra, in which solutions of known strengths yielded spectra with a certain number of lines of definite length and strength."

LIGHTNING PROTECTION — "The problem of protecting electric apparatus against lightning has not been altogether one of invention; it has been quite as much one of careful and patient observation. Four years ago it was customary to place a single lightning arrester at the point where protection was desired. Today the same point is protected by distributing line arresters at frequent intervals over the system."

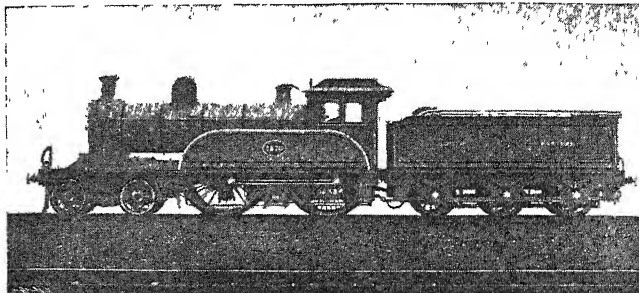
INDUSTRIAL EDUCATION — "We are confronted with the curious spectacle of employers with vacancies which they cannot fill, and an army of unemployed clamoring for work which they cannot get. Our progress in the appliances of the mechanical arts has outstripped our present methods of turning out workmen competent to handle those appliances. This growing scarcity of the skilled mechanic is undoubtedly due to the decadence of the apprenticeship system and the inadequacy of our present industrial and trade schools, excellent as they are, to meet the growing necessities of the case."

OCEAN LINER — "The largest ship in the world is building at the Vulcan shipyard in Bredon, near Stettin, Germany, for the Hamburg-American line. . . The new monster steamer has a length of 625 feet on the waterline, and is therefore considerably larger than the Campania, which is 600 feet in length between perpendiculars. The engines will have 27,000 horse power and a speed of 22 knots is expected."

FLIGHT — "If man does learn to fly by mechanical means, or even to float for an indefinite period by a balloon, then Lilienthal's death, the flight of Langley's machine and the

other achievements will be a group of notable occurrences. Slowly a tangible theory of soaring has been evolved. The support given to an aeroplane in horizontal motion through air has been experimentally tested and has proved surprisingly great."

LOCOMOTIVE — "Northeastern Railways (England) No. 1870 is the second locomotive of its class to be turned out. . . It must be admitted that within the limitations imposed by the English custom of placing the cylinders inside the frame, and hiding the working parts from view, which to American eyes always appears to rob a locomotive of much



of its charm, this is a very handsome and well-proportioned machine. . . The driving wheels, 7 feet 7 inches in diameter, are the largest set of four coupled wheels in the world, and were only exceeded by some 8 foot 3 inch six-coupled wheels tried on the Continent some years ago."

LOCKS — "The Yale lock manufacturers have proved that in a patent lock having six 'steps,' each capable of being reduced in height twenty times, the number of changes or combinations will be 86,400. Further, that as the drill pin and the pipes of the keys may be made of three different sizes, the total number of changes will be 2,592,600."

EXPORT — "An entire locomotive making plant will be taken soon to St. Petersburg from Philadelphia on the British steamship Laleham."

100 Years Ago in . . .

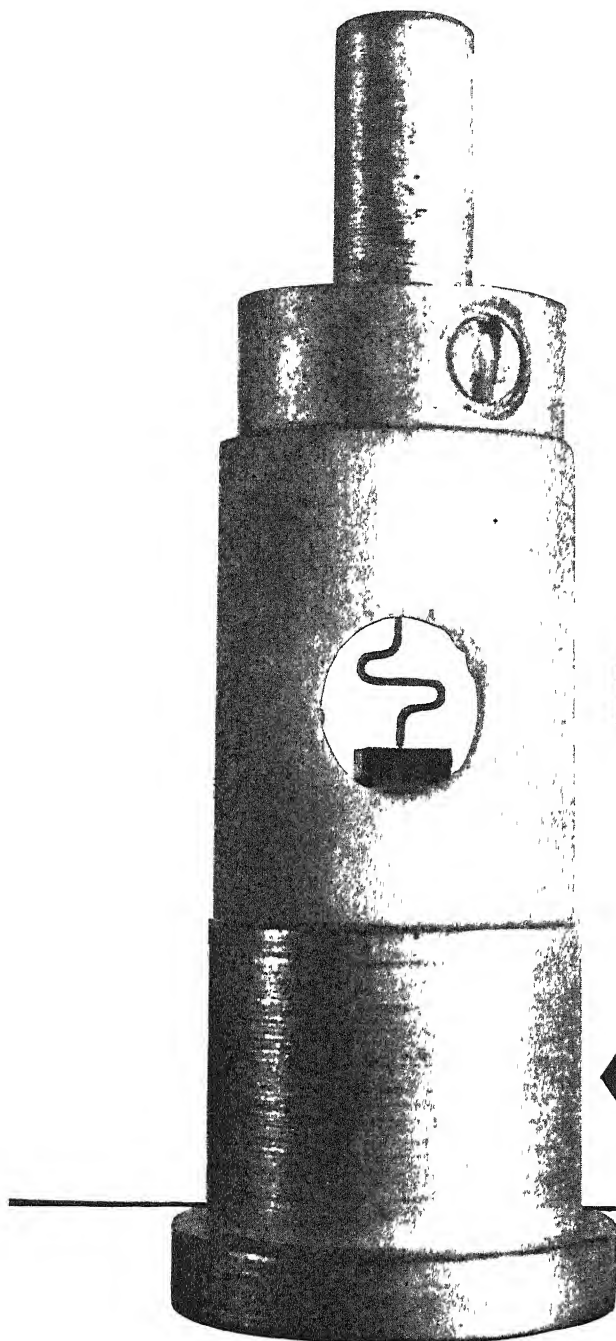


(Condensed from Issues of August, 1846)

IRON — "The new furnace at St. Clair will produce 80 tons of iron a week, or 4,000 tons a year, which, manufactured into bar or railway iron, will give 3,200 tons, worth at \$75 per ton, \$240,000."

WAGON BRAKE — "A patent has been recently granted for an invention that consists of a simple arrangement by which the rear end of the pole of a wagon or stage coach, by being permitted to slide back two or three inches through a groove, by this motion, operates a pair of brake-blocks against the rear side of the forward wheels; thus impeding the wheels by the action of the horses in holding back the pole."

PAVING — "The new pavement of granite blocks in State Street, Boston, is much admired and approved, and appears likely to prove much cheaper eventually than the uncouth old fashioned pebbles. The blocks are judiciously arranged so that all the seams or interstices run diagonally across the street, thus evading the danger of having the seams worn much faster than the faces of the blocks."



Crystal detector—1946 model

ENLARGED
7 TIMES

ONE INCH

Remember the crystal detector in the first radios — hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories' scientist thought back to the old crystal.

Silicon of controlled composition, he discovered, excelled as a microwave detector. Unlike the old-style natural crystals, it was predictable in performance, stable in service. From 1934 to Pearl Harbor, the Laboratories developed silicon units to serve microwave research wherever needed.

Then Radar arrived. The silicon crystal came into its own, and found application in long-distance microwave Radar. Working with American and British colleagues, the Laboratories rapidly perfected a unit which the Western Electric Company produced in thousands. It became the standard microwave detector.

Crystal detectors are destined to play a big role in electric circuits of the future. They will have an important part in Bell System microwave radio relay systems. In various forms, they may reappear in radio sets. Here again Bell Laboratories' research has furthered the communication art.

BELL TELEPHONE LABORATORIES



EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED ECONOMIES AND IMPROVEMENTS IN TELEPHONE SERVICE

Previews of the Industrial Horizon

WHAT'S IN A NAME?

IF ANYONE ever doubts the value of brand names in a competitive market, let him take heed of the present situation in the retail radio-receiver field. Production has been pushed to nearly record heights by "quickie" manufacturers. Would-be purchasers of radio sets have the money to buy. Retailers, at least in large cities and surrounding areas, have plenty of sets on their shelves. But, despite the demand for receivers, sales are slow. Unknown brand names—let's coin a few, such as Ethermaster, Tonamatic, and Electromystic—just don't move. Unknown, unadvertised, unsung in every respect, these receivers are being severely left alone by the buying public.

Some pinkish students of economics might ascribe this situation to defects in our system of production, advertising, and distribution. Actually, it finds its basis in a solid foundation of public faith in proved materials. When such firms as RCA, Westinghouse, Zenith, General Electric, and Emerson—to name but a few—are in a position to place radio receivers on the market, and to back them with their advertising and their reputations, the public will receive their products with open arms. In the meantime, that same public will sit on their pocketbooks and await the time when they can spend their money for radio sets which they know by name.

All of this lends added force to the overall subject of free enterprise and competition. Produce a better mousetrap, prove its ability, tell people about it, and the path will be beaten to the door. But try to crash even a seller's market with an unproved mousetrap and the path will be overgrown with weeds. In the long run, industry can deal best on integrity which backs brand names, rather than on opportunism that takes momentary advantage of circumstances.

RAMIE—WONDER FIBER, OR . . .

FOR THOUSANDS of years the fibers of the ramie plant have been known as a fabulous material with about the same strength as mild steel for the same weight. These fibers can be made up into durable and attractive clothing. They resist deterioration by moisture and have high wet strength. Fishing lines and nets of ramie fiber are strong and long wearing. Further, ramie fibers can be stapled and spun on either cotton or woolen systems. They are also valuable industrially in heavy belting, packing, filter cloth, upholstery, carpets, draperies, and blended fabrics of many kinds.

Wherein, then, lies the answer to the ramie problem that has cropped up perennially for many years? Known as the Oriental wonder fiber because of its use in the Orient for many hundreds of years before Christ, there is still all too little knowledge of the best ways of growing and handling it by modern industrial methods.

Now, it appears, the whole problem of ramie is being attacked in a rational manner. Probably ramie will never compete commercially with cotton and wool because the ramie plant is subtropical in nature and cannot be produced over as wide an area as competitive fibers. Yet, because of its outstanding advantages, it will have a real place of its own when commercially produced in this country.

Foremost among the problems of ramie is the matter of decortivating—stripping the useful fiber from the surrounding plant bark and skin and from an obstinate gum seemingly placed as an obstacle to the desired imbedded threads. In the Orient, where hand labor is the cheapest part of a production program, a Chinese laborer can strip or decorticate a few pounds of fiber for an equally few cents a day. The product is excellent, but production is low. This, then, is the problem that American producers of ramie must face.

Today, several millions of dollars are being invested in Florida in ramie projects. Prominent in the work are the powerful United States Sugar Corporation interests, coupled

By A. P. Peck

with Newport Industries, Inc., and the Sea Island Mills, all of which are intent on working the Everglades area for all it is worth. Here the soil is composed of decomposed vegetation, ideal for propagation of ramie, and thousands of acres are planted to ramie, with processing plants completed or under construction.

Still experimental work continues. While an acre of Florida Everglades soil will produce 30 tons of ramie plants, these 30 tons will yield only one ton of fiber. Thus the transportation problem enters the picture. Newest technological possibility is in the form of portable decortivating plants which will work right in the field. And when the problem is finally licked, American science will have another commercial fiber into which to sink its teeth.

In the meantime, Florida has no monopoly on the growing of ramie, although the Everglades area appears to hold advantages. Acreages are being planted in Louisiana, Mississippi, Texas, and California. It appears that a new textile-fiber race is on, backed by a few thousand years of hand labor.

DEPRECIATION VERSUS OBSOLESCENCE

SO SOUND and sane is the philosophy propounded by a brochure from an industrial company which recently came across our desk that we cannot resist the temptation to quote:

"Economics teaches us and industrial history shows that when a company cuts the cost of a product, it can offer that product at a lower price. As the price goes down its potential market increases. As its market increases, its volume goes up. As its volume goes up—it can hire more men. One of the fundamental principles of our competitive economy is that jobs are created by increasing the productivity of the worker.

"The modern machine tool is an important factor in this cycle of events. It is industry's instrument for reducing costs, and it reduces costs by increasing output, by doubling and redoubling the productivity of the individual worker."

This leads up to a question: Should this instrument, then, be subjected to yardsticks of obsolescence, rather than to demands of depreciation? Forward-looking executives are minimizing obsolescence in their plants; are measuring machine-tool usefulness in terms of production efficiency rather than in arbitrary years of tool life. They view these tools in the light of what they can do and not of their age.

More thinking of this kind is necessary to the American way; references will be given on request.

FOR FUTURE REFERENCE

HEAT SEALING of plastics sheeting, promoted by RCA, is being used in production of dress shields, bathing caps, raincoats, shower curtains, and the like; many such products can be made faster, better, and more economically through the use of electronic heating . . . Another plastics item: These materials are notoriously sensitive to heat and cold, but now Du Pont reports Teflon, an electrical insulating material that will withstand heat up to 600 degrees above zero, Fahrenheit, and down to 75 degrees below zero, with resistance to effects by ordinary chemicals . . . Men who work with machine tools should be taught the *why* of things as well as the *how*; Shell Oil Company is advocating this procedure with new literature on lathe operation principles.

Magnesium: Inexhaustible Metal

TECHNICALLY this is still the "iron age" of man's development, but this era or the period immediately ahead is also called, with varying degrees of accuracy or optimism, the chemical age, the plastics age, the air age, the atomic age, or the light-metal age. The latter, and one of the most plausible of the so-called ages, is partially based on the contention that magnesium will eventually replace iron as the world's basic constructional raw material. Hence, it might be feasible to call the next age of man the "magnesium age."

This implies, however, that the total American production of magnesium would probably have to reach more than 25 million tons per year, as compared with an optimistically estimated 1946 production of 25 to 38 thousand tons. This, in turn, would mean that magnesium as an industry would have to grow to about a thousand times its present size. Moreover, before this could happen magnesium's present and potential chief competitors—iron and steel, aluminum, structural plastics, copper, and so on—would have to have reached a state of depleted or vanished supply, prohibitively high prices, and technical inferiority to magnesium in the tonnage markets.

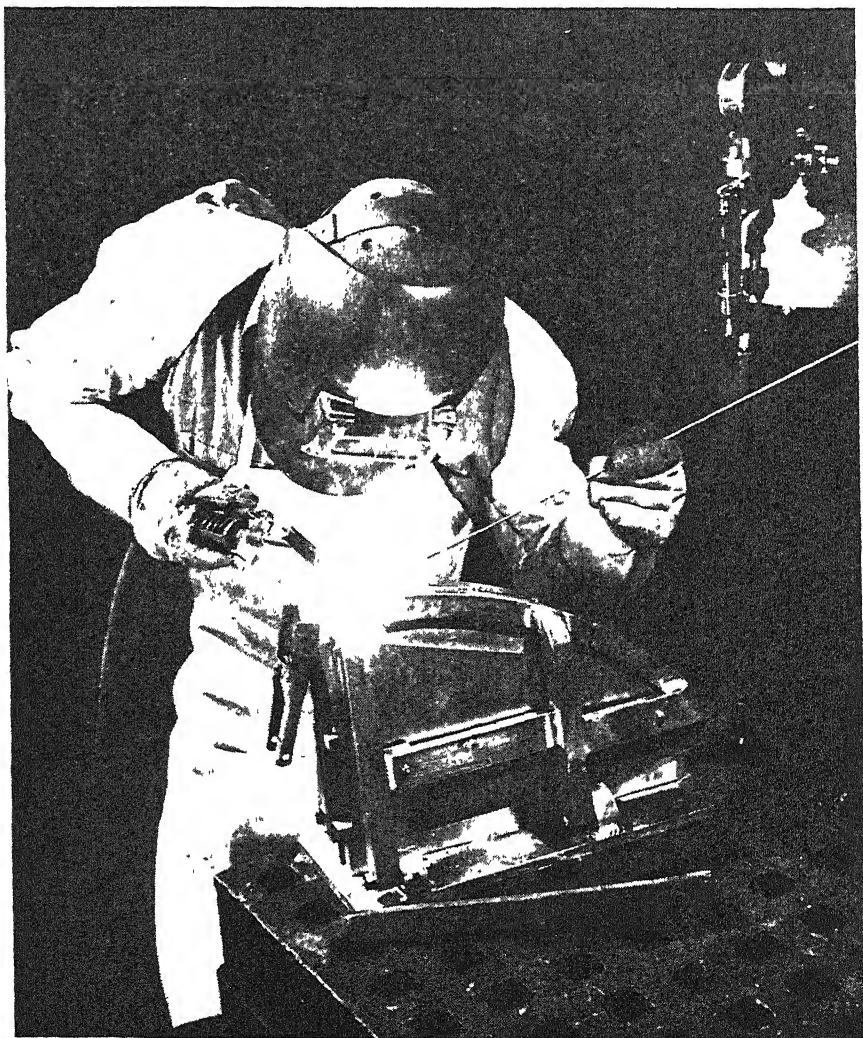
Actually, the production of some of these competitive materials is steadily rising or their prices are falling, while among all the engineering metals technical quality is steadily being improved. It is evident, therefore, that if magnesium is to become the prime raw material it is not likely to do so for scores of years or perhaps centuries.

But it is also evident that magnesium does stand a good chance of achieving this ultimate goal on some distant day, and that in the much nearer future it will grow rapidly

When Other Metals Reach the Economic Vanishing Point, the Seas Will Still Hold Unlimited Quantities of Magnesium. Today, this Remarkable Metal is Slowly Gaining in a Competitive Market. Its Strength, Machinability, and Lightness are Important Benefits

By FRED P. PETERS

Editor-in-Chief, *Materials & Methods*



COURTESY THE LOWE CHEMICAL COMPANY

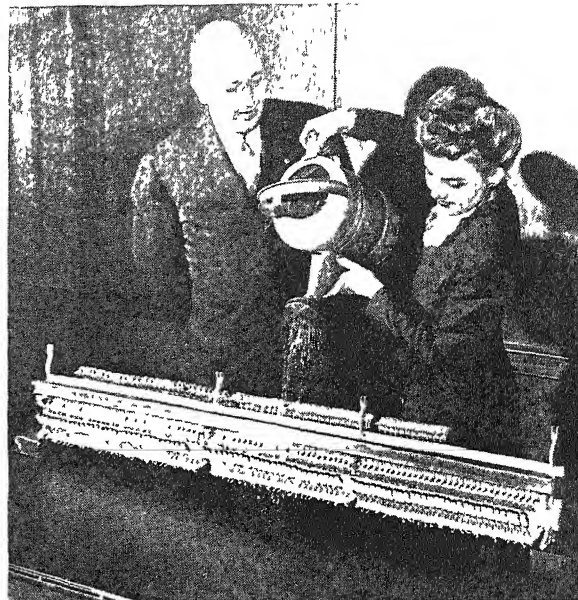
Welding magnesium alloy with a helium-shielded electric arc; a tungsten, rather than carbon, electrode is used. Magnesium alloys are also weldable with gas

to become a major competitor of the heavier basic metals for hundreds of uses as yet unimagined.

MAGNESIUM TODAY—At present, the going is not too easy for magnesium. It is still young as an engineering metal and its established uses have been predominantly military in nature. The number of plants and engineers familiar with magnesium, and the number of peace-time product applications that can serve as stimulating examples, are still relatively small—too small at this moment to occupy fully the war-expanded production capacity of the industry. Also, magnesium has cost problems. It is competitively at an original-price disadvantage with respect to aluminum, steel, cast iron, and other common engineering materials. And its acceptance is hindered by certain prejudices and misconceptions that only persistent and aggressive education can eradicate.

But producers and fabricators of magnesium are anything but pessimistic, and they are on sound ground. Magnesium's position from now on will continually improve. Several factors favor a steady—perhaps, eventually, an accelerating—growth for magnesium. These factors include: extractability from an inexhaustible raw material—sea water—at a reasonable and steadily decreasing cost; and technical superiority over all other metals with respect to lightness and machinability. The last points are important in a world that places increasing value on mobility, comfort, and mass-production manufacturing.

Extruded magnesium parts combine with plastics to replace wood and make this piano action virtually waterproof. New uses for the light and workable metal will appear as more engineers come to know its advantages



If the eventual thousand-fold growth of an industry seems fantastic, it should be considered that magnesium's annual production volume expanded 100-fold in just the five-year war period. In 1939 the American magnesium output was six million pounds; by 1944 the capacity of the industry had reached 580 million pounds. The "magnesium industry," which previously comprised one primary producer and a mere handful of fabricators, now is banded into a trade organization, the Magnesium Association, whose members include four or five producers and more than 45 fabricators of the light metal.

One of the outstanding characteristics of this still-infant industry is the strength and stability of its leading members. Such companies

as Dow Chemical Company, American Magnesium Corporation, and Revere Copper and Brass are enthusiastically and effectively sharing the technology with the rest of the industry and intelligently educating their markets on the advantages and limitations of magnesium.

The war's end left the industry with an enormous immediate task of finding markets for most of its capacity where virtually no markets existed before. Yet, more new uses for magnesium have been contemplated and started since V-J day than in the five-year period before the war, and users are now climbing on the bandwagon at an accelerating rate.

PRICE FAVORS USE—Future price trends are going to increase further the rate of application for magnesium. Since 1915 the price of magnesium ingot has fallen from \$5 per pound to about 20 cents per pound. At its present price, magnesium is more expensive on a unit-weight basis than aluminum, but is somewhat less expensive on a unit-volume basis. It is reliably predicted within the industry that the price of magnesium will be lowered 25 percent in the next five years, and that its fabricating costs will also be significantly reduced by virtue of technological improvements.

These forthcoming price changes are closely related to the development and increasing importance of the Dow process using sea water as the source of the magnesium chloride from which the magnesium metal is eventually electrolyzed. Built in 1940 and 1941, the sea-water plants and processes have demonstrated their ability to produce magnesium at lower costs than other



Light enough for one man to handle, magnesium aircraft wheels carry heavy loads

• LOOKING AHEAD •

Advantages of magnesium—other than lightness—will be exploited... Production of raw metal will increase and price will decrease... Cost will become a less-important factor... Engineering and design will welcome easy fabrication... Early-birds in applications of magnesium as a structural metal will gain a desirable marketing edge... Predictions of a bright future based on sound logic.

methods, and will probably soon become the major production processes for the metal.

Because of the sea-water process—and to a lesser extent because of the undiminishing availability of the workable magnesium minerals in the earth—magnesium appears to be the only potentially “basic” material of which the supply is actually unlimited or inexhaustible. One cubic mile of sea water, for example, contains the equivalent of 9.2 billion pounds of magnesium metal.

At the present time, no other engineering material, including plastics produced from agricultural raw materials, offers this same possibility of a continuing supply without a necessary rise in extraction cost. And while this may be of little economic importance from the standpoint of today's or 2046's materials engineering, it will be the consideration that will have outweighed all others in that dimly distant future when readily extractable high-grade deposits of iron, aluminum, zinc, lead and copper ores, and of coal and oil, have reached exhaustion.

LIGHT BUT STRONG—From the engineering point of view, as well, magnesium's position may be expected to become steadily stronger relative to its competitors. Today, it is the lightest of the structural metals, with a specific gravity one quarter that of steel and two thirds that of aluminum. Its alloys are sufficiently strong that many products will be both stronger and lighter when made of magnesium than when made of aluminum or steel.

On the basis of equal strength, for example, a magnesium part may save 70 percent of the weight of a similar steel part. Once it becomes generally appreciated that the use of magnesium not only can permit weight saving without sacrifice of structural strength but also can simplify design by allowing the use of thicker and therefore stiffer sections without adding to weight, the

conquests of magnesium will start to add up. Lightness will be particularly important as man takes increasingly to the air and to higher-speed land vehicles and sea-going vessels, all of which place a premium on light weight. Further, most people favor those aids to daily living that are lighter to lift or less heavy to push around.

The damping capacity—ability to absorb vibrations—of magnesium alloys is now known to be higher than that of aluminum alloys and many other metals, and to approach that of cast steel. This means that magnesium parts run quieter, are less likely to transmit vibratory stresses to adjacent parts, and are less subject to fatigue failure than if they were made of other metals.

Another discovery that some 30,000 new magnesium-fabricating plant employees made during the war, but which thousands of others in industry have yet to learn, is that magnesium is one of the easiest to work of modern materials. It is beyond dispute the most machineable engineering metal, requiring only from one sixth to three fifths the power needed to machine most of its important competitors. It is also among the most weldable of metals and one of the few, along with aluminum, on which deep draws can be made from hot sheet metal in one operation.

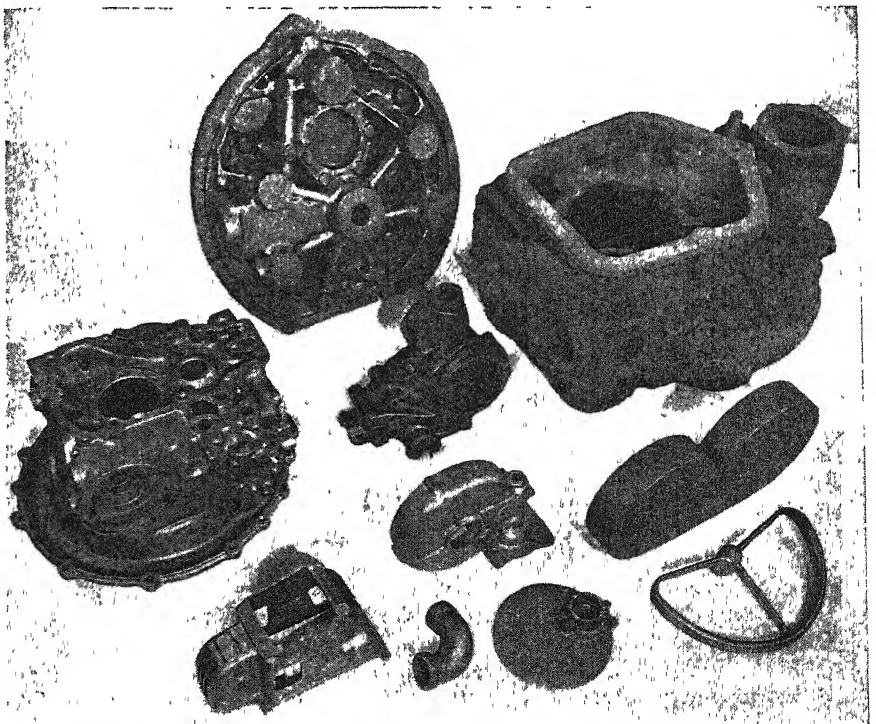
Where corrosion-protection is needed, and this is required less often than was formerly supposed, a large number of chemical finishes and paint treatments—simple, quick, and inexpensive—are available. And

magnesium's so-called “fire hazard” is now widely understood for what it actually is: a hazard only when handling fine magnesium powders or the molten metal. Solid pieces and parts made of magnesium alloys are no more flammable than they would be if made of aluminum, steel, zinc, or copper.

Technical developments now available or in the making presage a steady rise in the product appeal, processing efficiency, and ultimate consumption of magnesium. “Super-strength” magnesium alloys are heralded as a challenge to structural steels and heat-treated aluminum alloys. A series of highly pure magnesium alloys have exceptionally good corrosion resistance. Giant forgings soon to be available in magnesium alloys provide, in effect, a new type of engineering material. The rapid development of shielded arc welding; of cerium-bearing alloys for high temperatures; of new, strong die casting alloys; of castings that are free of micro-porosity; and of magnesium sheet for stressed-skin aircraft structures are only a few of the technical foundation stones in magnesium's future.

WEIGHT OR COST?—The cost factor is still a sharply restricting agent in expanding uses of magnesium. This situation will improve as the raw material price goes down and as still more efficient fabricating methods are developed—the latter being one of the goals the industry has specially set for itself.

The design economies achieved in the aircraft industry through the



Magnesium-alloy sand castings for aircraft use; intricate shapes are possible



All-metal magnesium skis do not warp, are lighter, faster than wooden

use of magnesium floor beams for cargo ships and of stabilizers with magnesium shells are familiar to many. This couples neatly with the fact that a light-weight design may be initially more expensive but return much more than this extra cost to transportation equipment operators in increased payload or reduced power charges during the service life of the equipment.

Thus in many cases and with certain forms of alloys, the use of magnesium may be more economical, one way or another, than some other material. However, although lightness is still the dominant factor leading to the choice of magnesium in most present-day applications, some of the new uses that magnesium already has found in post-war products involve a cost advantage for the user. A magnesium lawn mower, for example, now being made in lots of 50,000 per month, incorporates magnesium-alloy castings in successful competition with cast iron on both a cost and durability basis—besides the chief advantage of “less push.” For furniture, too, and even for auto and truck wheels, the cost comparisons are close. But for most of the new uses such as canoes, wheelbarrows, griddles, skis, auto pistons, crank cases, gravity roller conveyors, baby carriages, sleeping-car bed frames, radio towers, truck structural beams, and so on, the cost factor has been subordinated to lightness or some other consideration.

IRON IN RETROSPECT—The problem that magnesium faces today and the probability that—decades or centuries from now but nevertheless

eventually—it will replace steel as a basic material has been intriguingly presented by one of the industry's leaders. Iron and steel, he reminds us, were not always as cheap as they are now, and their production a century ago was measured in thousands rather than millions of tons. There is no evidence that the problems in the magnesium industry are any greater than those faced and overcome by steel.

Suppose, to continue the analogy, that the positions of steel and magnesium had been reversed, with magnesium the beneficiary of 50 years of commercial development and use and steel a brash newcomer. Suggestions that steel products could compete in cost with magnesium would be considered highly optimistic, and as barriers to such a situation would be mentioned the excessively high melting temperatures needed for steel, the expensive refractories necessary, the heaviness of the material, and of course its devastating and expensive propensity to rust.

One would most probably compare these qualities with the low-melting, light-weight magnesium alloys and conclude that steel could never be cheap enough to compete for the uses that magnesium had so firmly established for itself.

Which is another way of saying that if steel could achieve its present economic position in such a short period, magnesium should certainly be able to match that position eventually.



ALUMINIZED STEEL

*Resistant to Corrosion,
Reflects Heat Well*

A DIP-COATED steel product that will soon take its place with tinplate,terne, and galvanized steel in the array of inexpensive rust-protected sheet steel is Aluminized steel.

Aluminum-coated steel has, as special advantages, good corrosion resistance, heat resistance, and heat reflectivity. It has been successfully applied in automobile mufflers and for firewalls in airplanes. Other applications now under study include oven liners in domestic ranges, heat-exchanger tubes, and similar uses.

The weight of aluminum applied during the hot-dip-coating process, developed by American Rolling Mill Company, is the same for all gages—about ½ ounce of coating—total, on both sides—per square foot of sheet. The actual thickness of aluminum

film is 0.001 inch on each side—much thicker than tin-plate coatings of the same weight, because of the lighter specific gravity of aluminum.

COPPER-BEARING

*Iron and Steel Have High
Strength and Corrosion Resistance*

GREATLY increased use of copper-bearing cast irons and steels—from 2000 tons to 13,000 tons in ten years—stems from the much improved characteristics obtained from the addition of small percentages of copper. For example, addition of 0.15 to 0.20 percent copper cuts corrosion of plain carbon sheet steel exposed to atmosphere by 50 percent. Higher amounts of copper contribute strength. Resistance of 18:8 stainless steel to boiling dilute sulfuric acid is increased 90 percent with 2 percent copper added. The use of copper, molybdenum, and chromium in gray cast iron is said to develop a tensile strength of over 60,000 pounds per square inch.

EXTRUDED WELD-ROD

*Alloys Iron Base and
Powdered Coating in Use*

WELDING rod made by extruding a combination of powdered metals and ingot-iron wire is arousing interest in both the welding and the powder metallurgy fields.

In making the stainless steel weld-rod, base wire (ingot iron) is clad with enough powdered chromium, nickel, manganese, and silicon to produce under the welding arc a weld deposit of standard stainless steel. The clad wire is extruded just as fluxes are now extruded on drawn welding wire; the extruded product is then sintered.

Close control of powder analysis, particle size, mixing, and extruding pressures is said to result in a composite welding wire that yields consistently good deposits and at lower cost than conventional wire.

ENGINE BLOCK

*Die-Cast In One Piece
at Three-Per-Shot Rate*

LATEST development in large die castings is the production as a one-piece die casting of a combined engine cylinder block and crankcase. The castings, made of aluminum alloy, weigh about 15 pounds each and can be produced at the rate of 40 per hour. The machines cast up to 65 pounds of aluminum—three of the engine castings—in each shot. Westfield Manufacturing Company is casting the units for Jack and Heintz Company.

Is Soap Slipping?

• LOOKING AHEAD •

Foods, cosmetics, and toothpastes will feel the impacts of "soapless" soaps... Water-base paints, sprays for agriculture, industrial "soluble" oils will benefit. Surface active agents can make "impossible" processing methods work... Can be production "catalysts."

SYNTHETIC detergents, made either from petroleum products or from less fats than a comparable quantity of soap, can do most of the things that soap can do and many things that soap cannot. Moreover, they can be tailor-made for a particular use.

Soap has long been almost unique, among thousands of materials, in its characteristic properties.

Of these properties, soap has, first of all, a detergent or cleaning action. Every day advantage is taken of the fact that soap and water remove dirt much more easily and effectively than water alone. Secondly, soap has a wetting action. Pure water will often collect in little droplets on a surface, such as glass, while a soap solution will spread out over and wet the surface. Also, fabrics will "soak" faster in a soap solution since they are more easily penetrated by the solution than by plain water. Still a third characteristic of soap is its ability to disperse solids, liquids, and gases so intimately in water

Aided by the Fats Shortages of Two World Wars, "Soapless" Soaps are Moving in Rapidly on Tasks Long Regarded as Soap's Own Province: More than 300 Wetting Agents, Detergents, and Emulsifiers are Now Made. Many are Specialized; Others, General Purpose

By HOWARD C. E. JOHNSON, Ph.D.

Chemical Editor, *Chemical Industries*

that they are not easily separated. Suds and lather are simply dispersions of small air bubbles in soap solution.

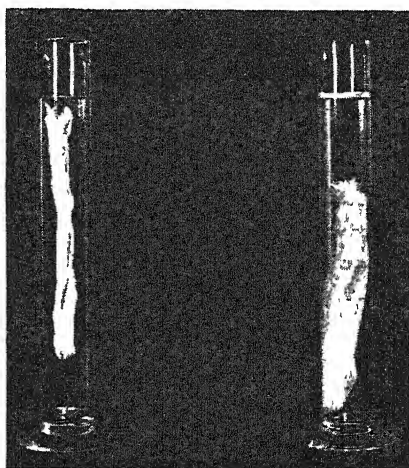
SURFACE ACTIVITY—These characteristics—detergency, wetting and penetration, and emulsification and dispersion—are all manifestations of what the physical chemists call "surface activity" because they involve the surfaces of the soap solu-

tion and the textile fiber, the oil droplet, the particle of dirt, or the sheet of glass. Of chief importance is the fact that soap lowers the interfacial tension—the barriers between the separate substances are broken down, enabling them to mix and, what is more important, to stay mixed, more readily.

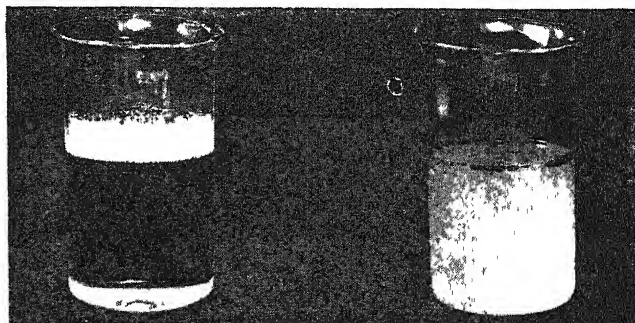
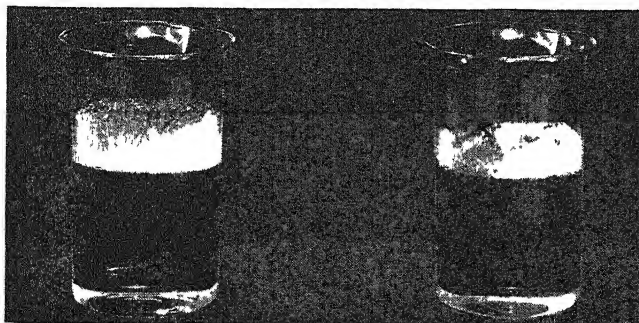
This concept explains in a limited way the action of soap. Wetting and penetrating ability are exhibited when soap reduces the disinclination of two dissimilar substances—the water solution and the textile fiber, for example—to mix. Its function might be likened to that of a hostess at a meeting of strangers.

In detergency, the soap solution wets both the surface of the material being cleaned and the particles of dirt and oil adhering to it. It interposes a thin wedge of water between the two and prevents them from adhering to each other. Emulsification is essentially the same—the oil droplets or air bubbles are kept from rejoining by the thin film of soap solution surrounding them.

It should not be inferred from this oversimplified explanation that surface activity is completely under-

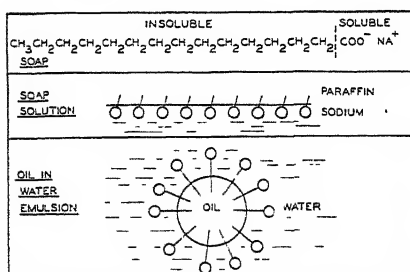


Sinking of yarn skein illustrates the wetting action of ordinary detergent (left) and synthetic detergent (right)



Acid, added to right-hand beaker of detergent (left) has little effect on suds as compared with acid-free beaker at left. Soap solutions (right) show suds in acid-free beaker at left but no suds and floating fatty matter when acid is added as at right

The water-soluble portion is the sodium or potassium salt of the oxygen-containing, acidic end of the fatty acid, as shown in the accompanying diagram. In solution the dissolved soap orients itself at the surface with the sodium "head" in the water and the paraffin-like "tail" sticking out. The "tails" are soluble



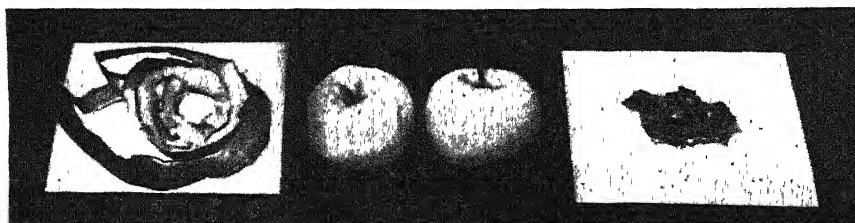
Where the water-insoluble portion is in the anion—as in soap, the sulfates, and sulfonates—the material

Still other types are non-ionic; that is, they are not salts. The solubility of the water-soluble portion depends on a grouping of several hydroxyl or ether linkages. Examples of these are the Spans, which are fatty acid esters of sorbitol anhydride. Sorbitol is an acid derived from sorbose—a sugar—and contains six hydroxyl groups.

It is generally conceded that soap is the best known cleansing agent in soft, warm, alkaline water. It is where these conditions cannot be

- Textile scouring, dyeing, and finishing
- Leather and paper processing
- Acid pickling of steel
- Metal cleaning and degreasing
- Etching and electroplating of metals
- Cosmetics and pharmaceuticals
- Industrial emulsions
- Water-base paints and coatings
- Sanitary and insecticidal sprays and dusts
- Bottle and container cleaning
- Printing pastes and inks
- Shoe, metal, furniture, and floor polishes
- Fruit and vegetable peeling
- Lubricant additives

DETERGENTS EXPAND—In view of soap's limitations, it is not surprising that the synthetic detergents industry has experienced a phenomenal growth. Not a pound was produced in this country in 1928, but by 1945 production had skyrocketed to 125,000,000 pounds annually. Stimulated by the fat shortage of World War I, the Germans developed soap substitutes at that time. Research progressed after the war, and in the early 1920's were introduced the fatty alcohol sulfates, later to become familiar in this



SCIENTIFIC AMERICAN • AUGUST 1946

country as Dreet and Gardinols. Manufacture of these was undertaken in the United States in 1929, and shortly thereafter a new type of detergent, the alkylated benzenesulfonates, were developed under the trade name Nacconol. During the intervening years about 300 commercial products have been introduced, and new variations are continually being discovered.

Just as World War I and its aftermath saw the birth of these new materials, the present period will undoubtedly see a huge expansion of manufacturing facilities and partly for the same reason—the fats and oils shortage.

Many of the synthetics are petroleum-based products, and of that raw material there is at present a comparative abundance. Many of them, on the other hand, use natural fats and oils just as does soap. But even here, the same quantity of fat or oil will give more synthetic detergent, pound for pound, than soap. Couple this with the fact that synthetic detergents are often equally effective at one third to one fifth the concentration of soap and it becomes apparent that a great saving can be made of the seriously curtailed fats and oils supply.

It is largely for this reason that synthetic detergent manufacturers have hunted at immediate plant expansions up to a total capacity of 400,000,000 pounds per year.

Mass production and improved processes have brought the price of the synthetics within shooting distance of soap prices. One product, for example, has been reduced to 13 cents per pound in industrial quantities—very little higher than comparable soap prices. Considering the higher efficiency of synthetics, the cost of using them is at least on a level with if not lower than the cost of using soap. For many purposes, too, the synthetics are so far superior that price is a secondary factor.

SYNTHETICS IN USE—A consumer survey of a large mid-western city, made early this year, showed that over a quarter of the families in the area buy synthetic detergents. Such a record by products introduced just a few years ago, and against the stiff competition of packaged soap goods, is proof of the eventual popularity of the synthetics.

Not only for general domestic laundering and cleaning do they find wide use in the home. Synthetics are incorporated in dentifrices because they taste better than soap, are widely sold as shampoos, and are being increasingly made into bar form as toilet soap for people

who are allergic or sensitive to ordinary soap.

As industrial detergents the synthetics find wide use in bottle washing in dairies and breweries. Many of the synthetics have been found to have a greater bacteriostatic action than soap, and an added bonus is the greater ease with which they soak off labels. They are also useful as metal cleaners, both with alkalis and with acids. Being stable to acid, they are uniquely useful in the pickling of steel, where they not only cleanse the metal of grease and carbon but also inhibit attack by the acid. In electroplating baths, where acids and heavy metal salts are present, the synthetics keep the metal surfaces clean and help avoid pitting, pinholes, and other plating difficulties. Moreover, they are being added to lubricating oils to keep sludge from depositing, and to photographic developing solutions to keep air bubbles from adhering to the film.

As wetting agents the synthetics find their largest industrial application in the textile field. Here they are used for scouring, dyeing, finishing, softening—any application, in fact, where the fibers must be treated with a water dispersion, emulsion, or solution. They are especially desirable for wool, which is sensitive to alkali, and for rayon, which does not stand high water temperature.

In addition, synthetics are now entering the paper and leather industries, where they speed the processing of the raw materials. Added to paper, synthetics increase absorbency; used in leather-dyeing baths, they afford greater penetration of the dye.

WIDE HORIZONS—One large use of these versatile materials is the wetting of dusts. They are used in air-conditioning equipment to wash dust out of the air, and in the formulation of wettable insecticidal dusts, such as lime-sulfur mixtures and DDT concentrates.

A novel agricultural application of the synthetic wetting agents is in conjunction with either caustic or strong acid in the chemical “peeling” of fruit. The most careful knife peeling of apples wastes at least twice as much fruit as chemical removal of the peel. A usual method is a short treatment with hot caustic to which a synthetic wetting agent has been added, followed by a wash with cold water and acidification with citric acid to remove the last traces of caustic.

The synthetics are also being formulated into a number of specialties, such as windshield cleaners;

metal polishes, scouring powders; mechanics' hand soaps; shoe, automobile, and furniture polishes, printing inks, and special industrial soaps.

The non-ionic agents are widely used as emulsifiers and dispersing agents. To discuss these alone would require a separate article, but some of the most important fields are water-base paints and other coating compositions; cutting and other “soluble” oils; paper, leather, and textile finishes; foods and beverages; cosmetics and pharmaceuticals; agricultural and sanitary sprays.

The list of specific applications of these materials is endless. In summing them all up, one manufacturer states: “Surface-active agents save money and time by decreasing the natural reluctance of dissimilar materials to mix. They can reduce the mechanical energy required and improve the performance and permanence of the final result by bringing surfaces closer together faster.”

* * *

BUCKWHEAT DRUG

*May Help Prevent
Weakness of Blood Vessels*

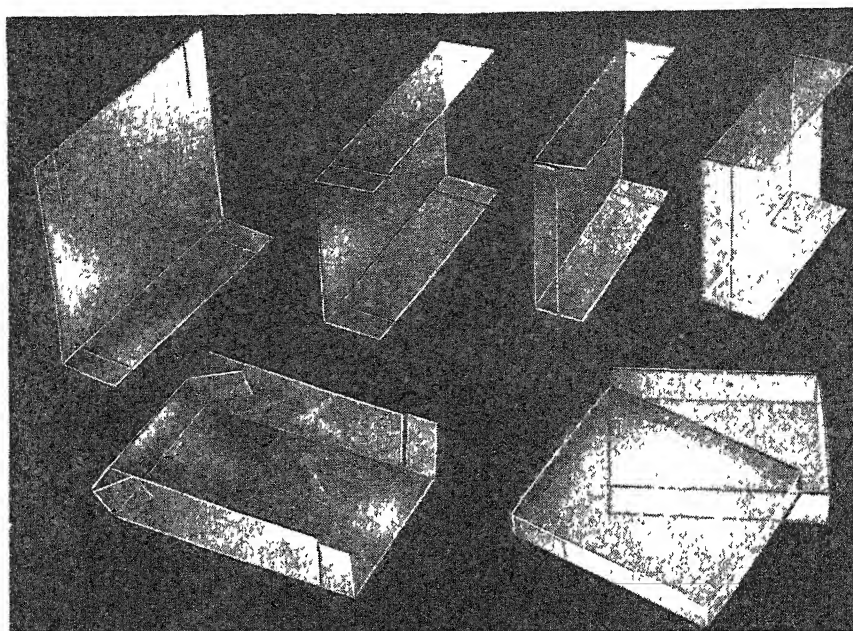
A DRUG, rutin, previously derived from tobacco by a laborious series of operations, has lately been found to be more plentifully and cheaply available from buckwheat. Rutin is reported to have an important effect in strengthening the walls of the tiny capillary blood vessels, thus lessening the possibility of their bursting should the blood pressure rise unduly.

Rutin, it is explained, is a preventive and not a curative. The yield of the drug from \$10 worth of green buckwheat is said to be as much as that from \$1000 worth of tobacco. Clinical tests are planned to supply the basis for licensing the product by the Food and Drug Administration, a necessary preliminary to its general use.

RAYON FABRICS

*May See Wider Use
as Result of Shrink-Proofing*

GLYOXAL is a recent development that is said to offer a successful shrink-proofing treatment for spun rayon. According to Dr. R. L. Bateman of Carbide and Carbon Chemicals Corporation, the process “will lead to a greater acceptance and use of spun rayon as a clothing fabric, for the disadvantage of rayon shrinkage is thus controlled chemically.”



Plastics boxes are simply fabricated, have both display and re-use values

PLASTICS

Pack It In Plastics

Packaging, the Last Step in Production, is Often the All-Important First Step in Merchandising. Whether Precision Parts Need Protection, Or Elegant Dainties Call for Plus-Feature Packages, Plastics are Available in More than 30 Basic Types and Many Colors to Aid the Sale

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

IT IS up to the package to attract the eye and induce the purchase. Thus has been described the key function of the package in today's merchandising picture. And thus is explained, in great part, the expanding use of plastics as a packaging medium. For these materials, in at least one of the 30 or more different basic types, possess every quality calculated to catch the eye—crystal-clear transparency, unlimited color range, formability, and light weight. These characteristics not only fit plastics to meet the requirements of eye appeal but they also adapt them to protection and convenience, factors of almost equal importance to packagers.

While appearance may always be an element to consider in the designing of a package, the requirements of protection for the merchandise or, on the other hand, con-

venience for the purchaser, may at times take prior place. Moreover, the designer may be asked to strike a balance between any two of these three packaging requirements, or to give heed to the entire trio.

Just how plastics' varying qualities of transparency, unlimited color, formability, light weight, and resistance to many acids, alkalis, and other agents, and to varying climatic conditions, fit them to packaging's need for eye appeal, protection, and convenience can perhaps best be illustrated by describing a number of new plastics packaging applications. Some of these feature display, some protection, and some convenience.

EYE APPEAL—Display, pure and simple, was the goal of J. P. Sawyer of Morse International, Inc. when designing the acrylic package for

• LOOKING AHEAD •

Re-usable containers that are more than just trinket boxes... Really fresh merchandise... Greater public demand for "smart" packaging will follow packers' recognition of plastics... From merchants' viewpoint, storage problems will ease... No rust or damage to displayed articles... Increased impulse buying because transparent containers "show" goods better... Better looking stores because packages themselves may be colorful.

Prince Matchabelli's gold-encrusted crown perfume bottle. The effect of a bottle of perfume frozen inside a block of ice and tied with a golden cord is an immediate eye catcher. Yet, had plastics not been used, it is doubtful whether the container would have been practicable. Although glass could have been employed, the fragility and the weight of this material might have proved serious handicaps. Plexiglas and Lucite, however, offered all the ad-



Courtesy Cudahy Packing Company
Mixing envelope of plastics typifies
consumer-convenience packaging ideas

vantages of glass, transparency in particular, but did not possess its limitations.

In appearance, it seems as though the perfume bottle is cast in a solid block of plastics; actually the transparent cube is made in two identical sections. Each half has a cavity on the inside that conforms to the outlines of one side of a crown bottle. Molding, rather than fabricating, was selected as the most practicable and economical method of producing this package. Still further to speed production, both sections are made the same size so there is no need for balancing the production of two different dies so as to give an even number of halves. Any two parts can be fitted together to form one cube-packages.

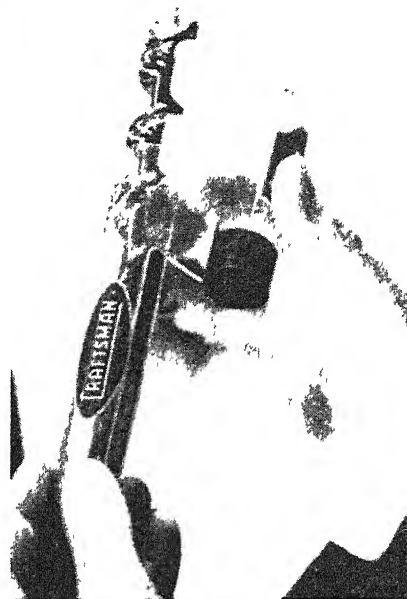
CONVENIENCE—A new flexible thermoplastic inner envelope for oleomargarine exemplifies the utility of plastics from the standpoint of convenience. Messy mixing dishes are eliminated since the yellow coloring can be kneaded evenly into the margarine while it is still tightly sealed within the plastics container. And there should be a saving in oleomargarine, too, since estimates indicate that every year 2½ percent of the total margarine production is lost through coloring waste.

Cudahy Packing Company is the first manufacturer to take advantage of this new container, developed by Leo Peters of Harris Hall and Company, and now being manufactured in experimental quantities by Visking Corporation, producer of the thermoplastic film itself.

This plastics film is factory-filled with oleomargarine, and a capsule containing the yellow dye suspended in edible oils is attached to the inside surface of the envelope. The film is then heat-sealed. The purchaser when ready to color the

product, pinches the capsule to force the dye out into the oleomargarine so it can be diffused by kneading.

The coloring operation with this new inner container requires only two minutes or less of kneading. Still sealed inside the envelope, the colored margarine may be put back in the paper carton in which the product is sold and blocked



Courtesy Celluplastic Corporation
Storage, without rust or damage, is
advantage to dealer and buyer alike

back into shape. The carton may then be placed in the refrigerator to allow the oleo to harden after which it may be easily cut in neat quarters or in fancy patties.

This package promises to eliminate returns due to leakage during hot weather; seal dirt out of the package completely, permit display on unrefrigerated counters; eliminate the use of dishes and pans formerly required in coloring, keep grease and hard-to-remove color stain off hands and clothing; and prevent margarine from picking up refrigeration odors.

The strength of plastics film plus its transparency and flexibility are essential to the success of this packaging idea. But equally vital are the thermoplastic's non-toxic qualities, its chemical stability in the presence of fatty acids and brine, its lack of color, and its low cost. Since the film can be made without a plasticizer, it imparts no odor or taste to the margarine.

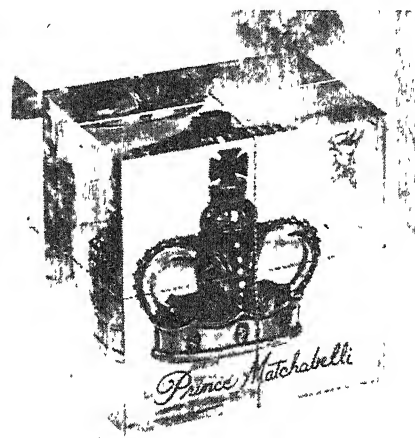
As in all plastics applications, whether they are in the field of packaging or in totally unrelated industries, the choice of the correct plastics is even more important than the decision to use them. How free a hand this leaves the designer

or engineer is evidenced by the fact that, taking the 30 basic plastics materials, thousands of special formulations can be made up to meet as widely varying demands as were made by the producers of the two packages just described.

PROTECTION—Today, the Navy is putting many units of the fleet and all types of armament and equipment in long-term storage—packaging them in plastics to protect them against time and the elements, yet keeping them ready for almost instant active duty.

The requirements for such "packaging" are economy, maximum moisture protection, and quick and easy removal. The answer, developed by Dr. William H. Holst and G. Russell Hersam of Butler and Company, and manufactured by R. M. Hollingshead Corporation, was a strippable coating based on Vinylite resins. Only compressed air and spray guns are needed for application.

The system begins with a frame—



Eye-appeal of plastics is apparent in this acrylic "ice-cube" perfume pack

work of pressure-sensitive tape built up around the object to be sealed. The spraying operation then applied to this skeletal frame consists of four steps. First the webbing solution is applied. This consists of a vinyl-resin solution to which a webbing agent, Saran, has been added to produce filaments when emitted from a standard spray gun. These filaments, extruded in a cobweb-like form, bridge over but do not adhere to the surfaces with which they come into contact. The web is built up to a point where sufficient strength is obtained to permit the application of the second coating.

The second coating, the moisture barrier, is a solution of Vinylite resins with the webbing agent omitted. This cover is built up to a

film thickness that will give the desired strength plus low moisture vapor transmission. Then a pigmented vinyl-resin top coating is added, the pigmentation being designed to resist the effects of the sun's rays as well as protect against general weathering conditions. This step is needed only for long-term outdoor storage.

Finally, regardless of whether a top coating is added, the protective package is evacuated of air and solvent fumes by the use of a hot-air blower.

It is conceivable that this processing will find wide application in the shipment of such equipment as refrigerators, washing machines, tractors, outboard motors, and other types of household and industrial units. Storage and shipment under any climatic condition will then hold no dangers for the manufacturer.

STRIP COATINGS—A different approach to the packaging of metal parts is to be found in the strip coatings. Rather than covering entire units of mechanical equipment, these coatings are best used for component metal pieces such as gears, bearings, and so on.

Ethyl-cellulose stripping was introduced to the packaging field during the war; since then a new type of coating based on cellulose acetate butyrate has made its appearance. This new material, with special characteristics of its own, is complementary rather than competitive to the ethyl cellulose compound. For example, it has lower tensile strength, higher elongation, and greater strippability. Hence it can be applied to and stripped from parts of greater intricacy. In addition, this cellulose acetate butyrate coating deteriorates less due to aging in the melting tank. It has approximately twice the load-carrying capacity of the ethyl cellulose compound and therefore can be applied to heavier parts without danger of "squeeze-out." With these advantages, however, it costs approximately twice as much as the ethyl cellulose compound; both the higher cost and the more versatile properties are due to the fact that it contains about 50 percent of plastics in the formula as contrasted to 25 percent of plastics in the corresponding ethyl cellulose formula.

TRIPLE-PLAY PACKAGES—Perhaps the more usual packaging application is one in which some of all the three factors—display, convenience, and protection—are needed. A new development of this type is found in the rigid, folded vinyl and acetate boxes of the John

H Oxley Company, licensor of the process and builder of the equipment. Solid corners, reinforced sides and ends if desired, and absence of any cement or solvent, are features of these packages which can be produced in sizes varying from a ring box to a container large enough to hold a blanket.

The folds in the plastics sheet and the equipment that makes these folds are the heart of this new boxing method. Almost as important is the die which permits the stamping out of almost knife-edge thin slots from the flat cellulose acetate or vinyl sheeting comprising the blanks for the boxes. After the flat vinyl or acetate sheets are die stamped, they are fed into a semi-automatic forming machine containing a knife-edge heater. With this equipment it is not necessary to heat the entire sheet of plastics; only thin lines need to be heated where the material will be folded.

Just as there is almost no limit on the size of boxes made by this method, so it is with the color and rigidity. Governed by the use to which the box is to be put, a customer may use 0.0075 to 0.040-gage plastics sheet. Material of 0.015 gage is, however, recommended for most

applications. And the boxes can be made in any color in which the plastics is available. This selection is further augmented by the fact that the top and bottom of a box can be of differently colored material. Thus, a clear, transparent bottom may have either a clear top, a red top, or one in any of a multitude of colors. Or the top may be clear and used with variously colored bottoms.

The protection offered by these boxes is excellent. Their convenience lies in the fact that a product may be viewed by the public through the transparent top, yet be guarded from the soiling usually attendant upon repeated handling by either the public or the sales force. Eye appeal is there, of course, and the boxes have the added advantage of re-use possibilities. After the original contents have been removed the container may be used to hold gloves, handkerchiefs, or other articles.

There are endless other types of plastics packages, but these examples show how the materials, if properly selected, can meet the demands for display, protection, and convenience demanded by packaging designers, product manufacturers, and the consumer.



COSMETIC BAG

*Prevents Leakage, is
Light and Flexible*

AS PROTECTION against leaky cosmetic bottles in traveling bags, a zippered vinyl case large enough to hold a number of bottles and boxes, as well as wash-cloths and soap, has been recently introduced. Stitched with nylon thread, the case is fashioned of an unsupported vinyl co-polymer film which is both flexible and strong. The material is called Elasti-Glass and S. Buschbaum Company manufactures the bag.

Vinyl is well suited to travel accessories as it is light in weight, water-proof, and resistant to oils and greases. It will stand up under packing, and will give good service in all climates, being impervious to fungi, mildew, extreme heat, or cold.

PLASTICS HORSE

*Weights 15 Pounds,
Supports 400 Pounds*

A NEW toy comprises a phenolic-laminate rocking-horse body, a mane and tail made from vinyl monofilaments, and eyes molded from cellulose acetate. Realism is achieved through the application of actual ponyhide skin to the outside

of the laminated body. No stitching is required for this work, casein adhesives being used instead.

The method of producing the body is an adaptation of the methods used in the fabrication of laminated helmets used for head protection by industrial workers. The hobby-horse body is first built up from phenolic-impregnated canvas sections in a criss-crossed pattern. This lay-up is placed in a cast-phenolic mold where air pressure of about 30 pounds forces the impregnated canvas outward against the forming die. Curing is accomplished by baking the parts for from six to eight hours under pressure.

Mounted on aluminum rockers, the horse stands 34 inches high and weighs about 15 pounds; it is said to support 400 pounds.

AUTO DOOR AND SEATS

*Now Formed of
Laminated Plastics*

AMONG the newer applications of plastics in the automotive field are taxi doors and folding seat backs constructed from Melmac resin impregnated barrier and Kraft cores. The laminating of these coverings, presently available in a mottled white, is the work of the Formica Insulation Company.

Conducted by KEITH HENNEY

Mechanized Wiring

Many Hand Operations in Wiring Various Electrical and Electronic Mechanisms Can be Eliminated by the Use of Sprayed Metal Coatings, Pre-Formed and Welded Harnesses, and Metallic Paints Applied Through Silk Screens. Costs Can be Reduced and Efficiency Increased

By JOHN MARKUS

Associate Editor, *Electronics*

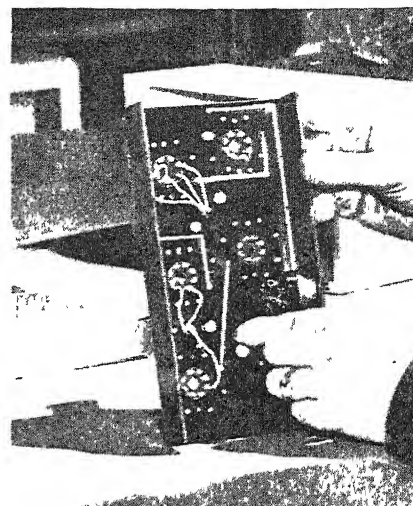
SEEKING means of offsetting skyrocketing labor costs, electrical, radio, and electronic equipment manufacturers are seriously considering mechanization of the wiring required in their products. To this end, many different wiring shortcuts are being tested in the development laboratories of alert manufacturers. As a result, new techniques are already in use as heralds of a trend toward speeding up the biggest hand-work operation involved in the production of electrical equipment having complicated wiring



Miniature tube leads are soldered to printed circuit; wires are eliminated

Elimination of soldering operations is one goal. The latest electronic adjustable-speed motor drives, made by General Electric Company for industrial applications, have all resistors, capacitors, transformers, and other components connected together by the use of screw-type lugs and terminals. Punch presses crimp the lugs over the ends of the connecting leads and long rows of terminal screws on insulating panels are provided for making connections between parts. Only the tube sockets and certain small rheostats and potentiometers have soldered connections, because these parts are commercially available only with soldering lugs as terminals. The labor saving occurs here not only in assembly but in maintenance of the equipment during use; the technician in an industrial plant can replace a defective part in a jiffy with a screw driver as his only tool. Faulty soldered connections both during manufacture and repair are thus eliminated, making for greater reliability of industrial electronic equipment. This same technique is also used extensively for other electrical equipment.

As conventionally done by hand, wiring is the most expensive part of the work involved in radio receiver production. It involves cutting wires to length, stripping insulation from ends, bending wires to shape, connecting the ends of the wire to the proper points, and then soldering each end of each wire in turn. For an average five-



Plastics chassis having sprayed metal circuits in sandblasted channels is neat, simple to inspect and service

• LOOKING AHEAD •

High cost of many electrical units can be reduced through use of new processes. . . Radio industry will make greatest gains but other electronic manufacturers will profit in proportion. . . What has been done with motor drives, radio receivers, loop antennas, and resistances, can be extended to other fields.

tube radio receiver this involves handling and soldering two or more wires or leads for some 40 different parts, often in a crowded under-chassis space which gives a result that looks much like a rat's nest—and often is equally frail.

AUTOMATIC WIRING—To overcome such difficulties, a method of applying all wiring to a chassis automatically in one operation with a spray of molten metal has been developed by Promenette Radio and Television Corporation. An all-plastics chassis is covered with a mask having cut-out lines where connections are to be made, and shallow grooves are sandblasted into the plastics. The process may in some cases be repeated with another mask on the other side of the chassis so that crossovers of connecting paths are separated by the insulating chassis.

The chassis is placed in a metalizing machine and molten metal is sprayed into the sand-blasted grooves through another mask. The molten metal hardens to provide the required connections between parts. Mounting of the parts in

drilled holes, with nuts and bolts or with rivets, serves to clamp terminals against the metal-filled grooves, achieving wiring without wires. Some soldering of external leads is still required, such as antenna and loudspeaker leads, but the process may eventually be further developed to make all connections at once.

Mechanization of wiring by this molten-spray process offers a number of advantages. Circuit and equipment design changes can be made as often as desired because masks are cheap and simple to make. Uniformity of production is assured because, if the mask is right, all connections must be correct. Performance is improved and the number of final alignment adjustments and tests is minimized since all wiring in critical circuits is precisely and uniformly positioned on all sets.

Another proposal for eliminating soldering operations involves forming stiff hookup wires to shape in punch presses, letting them slide down hoppers to correct positions in a jig on which tube sockets, resistors, capacitors, and coils have been previously placed either by hand or by other hoppers, then lowering a multi-electrode welding head over the assembly and electronically spot-welding all connections in one operation.

Instead of using bent-to-shape wires, narrow strips of copper can be punched out with all the required curves and right-angle bends taken by ordinary wiring, then welded to the terminals. Insulating buttons would be used here

to support the strips in as many planes as are required to prevent short-circuits where strips cross.

PRINTED WIRING—Development of the radio proximity fuze for mortar and anti-aircraft shells during the war resulted in perfection of a new technique for printing wiring directly on a ceramic surface with a silver solution by a silk-screen process that makes possible the mass production of ultra-compact amplifiers, pocket radios, personal telephones, miniature hearing aids, meteorological instruments, and electronic control units. In addition, the process permits applying resistors directly to the ceramic to give any desired resistance value, by applying a carbon solution with the silk screen or spraying it on through a mask.

The process, as developed by Globe-Union, Inc., consists essentially of the following four steps: (1) Circuit wiring is printed or stencilled (using silver paint) onto a suitable chassis or base material, such as a plate of steatite, (2) resistors in the form of a carbon and

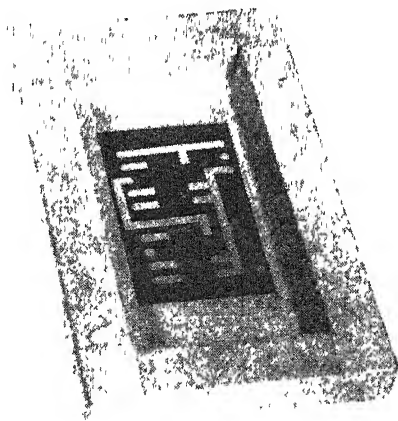
resin mixture are sprayed through positioning masks that locate them between appropriate silvered end tabs, (3) small disk-type capacitors, consisting of a high-dielectric-constant ceramic with both faces silvered, are attached directly to the silvered wiring on the plate; (4) terminals of other components such as tubes (or tube sockets for standard replaceable tubes) are soldered into appropriately located and silvered holes in the ceramic. Used with the newly developed sub-miniature tubes, the electronic circuit assembly made possible by this process is extremely compact.

Although the compactness of the method was the most important factor in its military application, other equally important and desirable characteristics are the uniformity of finished assemblies both in appearance and performance, high production speed, and ease of circuit checking. Uniformity is obtained since each circuit is an exact reproduction of the master pattern. High production speed is gained by the screening and spraying operations, which combine in a few fast mechanical operations the slower operations of cutting wires to length and soldering wires and resistors into place.

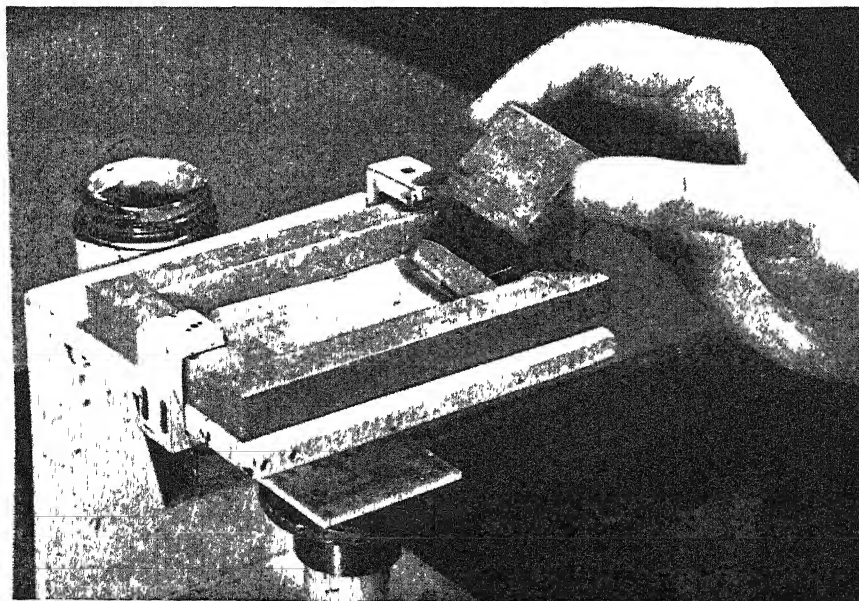
REPAIRS FACILITATED—Because of its two-dimensional nature and the open method of construction, circuits constructed by this new process lend themselves to rapid circuit tracing and repair. Faulty components such as resistors and capacitors which are on the chassis can be repaired, if necessary, by soldering a conventional component of equivalent value across each faulty part and opening the circuit leading to the fault.

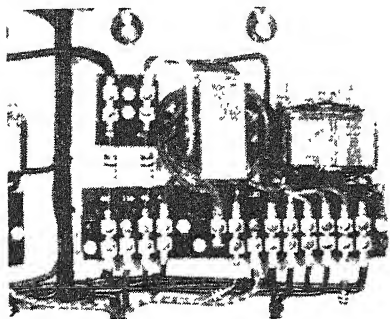
The leads between components are applied by a process in which the silver is intimately bonded to the ceramic. The metal is in the form of finely divided silver or silver oxide uniformly dispersed in a suitable vehicle. The consistency is adjusted with solvents to meet requirements for the specific type of application.

The method most commonly used for circuit reproduction is a screening process in which the silver paint is dispersed through the open mesh of a silk screen arranged as a mask to define the circuit. This makes it possible to print circuits of any degree of complexity. Complicated designs can be held to very close tolerances. The deposited or printed film thickness is very uniform and but little silver paint is wasted. The silk is stretched tightly on a wooden frame and



Simple silk-screen stencil (right) is used with applicator (below) to apply silver paste to ceramic plate. Part of printed circuit is seen under jig





Screw driver is only tool needed for replacing wiring on this equipment

coated with gelatin or polyvinyl alcohol, which is made photosensitive with potassium dichromate. A photographic positive of the circuit is held tightly against the sensitized silk screen and exposed to light. The portions of the sensitized coating exposed to light become insoluble in water. Those portions which are not exposed to light are water soluble and can be washed out. The parts that wash out from the design are to be printed.

The next step is to place the silver paint, in paste form, on one end of the top surface of the screen. The ceramic chassis or other surface to be painted is brought into contact with the bottom of the screen. A neoprene bar is moved across the top surface of the silk, pushing the paste ahead of it and through the open mesh of the screen pattern. The paint forced through the open mesh is deposited on the ceramic plate in a design which conforms identically to that of the screen pattern.

After applying the silver to the ceramic, the parts are placed in a furnace and heated to a temperature between 1300 and 1500 degrees, Fahrenheit. This temperature removes the vehicle and solvents, and intimately bonds the silver to the ceramic.

When making resistors, the process involves the application of an accurately controlled amount of resistance paint to the ceramic surface. The paint consists of a conducting material, a filler or inert material, and a vehicle or binder. By varying the quantities of these ingredients, paints may be obtained covering a resistance range from three ohms to 200 megohms per unit length.

The resistor paint is usually applied through masks by a spray. After air drying, the masks are removed and the paint is cured in an oven at 300 degrees, Fahrenheit, for several hours to produce stable resistors. A special resin coating is applied to the resistors to protect them against humidity and temperature effects.

Where necessary, amplifier, filter, or other control circuit assemblies may be printed on small ceramic blocks and plugged into a main chassis. Replacements can then be made just as easily as changing a tube. Furthermore, any tampering with a circuit by inexperienced personnel is immediately apparent, as ordinary resistors or capacitors soldered across the printed components will be clearly visible.

STAMPED LOOPS—Built-in loop antennas for table-model radio sets are being stamped out in a single operation by a variation of the printed-wiring technique. In this method, used by A. W. Franklin Company, a sheet of copper foil and an adhesive-covered insulating panel are placed in a special punch press that stamps out the rectangular spiral turns of the antenna coil and attaches them to the supporting panel in one operation. To get spacing between turns, the die forces the cut edges of each turn into the panel so that each turn is V-shaped and hence narrower than a flat strip.

Compared to the conventional wound loop mounted on the back of the cabinet, the new Airloop is lower in price and itself provides a back for the set. Accurate stamping of the turns means that no adjustment of the turns is necessary by the set manufacturer in final assembly to compensate for variations in winding. Over a million of these loops have already been turned out.

Thus is the highly competitive radio and electronic industry seeking, by mechanization of wiring, the answer to rising labor costs and shorter working hours. Whether any or all of these techniques will become standard practice depends upon the great host of human and economic factors that are governing the growth of the electronics industry itself.



GAS-STOVE GENERATOR

*Charges Batteries or
Operates Radio Equipment*

Heat from a gasoline burner is converted directly into electricity in a modern industrial application of the thermoelectric principle. The new thermoelectric generator provides a small, noiseless source of power for charging storage batteries and operating radio equipment. Three sizes have been developed;

one generates $2\frac{1}{2}$ volts at two amperes D.C. for charging the new two-volt storage batteries used in portable radio equipment, and runs for eight hours on a gallon of fuel; another gives 10 watts at six volts for charging standard auto storage batteries; the third has an output of 20 watts at 12 volts, enough to operate a 14-tube F-M combination transmitter and receiver such as might be used in cars for highway radiophone service.

In addition, heat is available for cooking or for warming up a room, even while electricity is being generated by application of the 1100 degree, Fahrenheit, flame to the banks of thermocouple units.

COFFEE

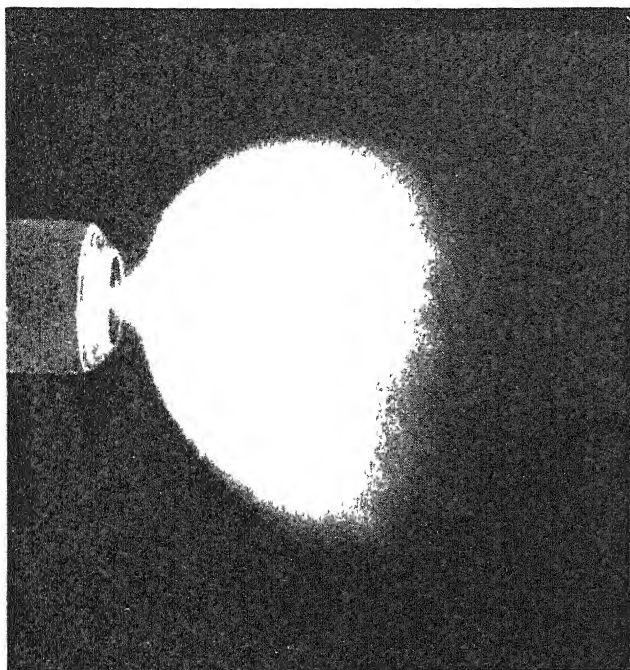
*Roasted Electronically
at Retail Market*

FOR ROASTING coffee on the spot in grocery stores and restaurants, an electronic coffee roaster approximately the size of a cash register has been developed by A. S. Torres, Colombian inventor. Green coffee, dumped into a hopper, is pre-heated to 900 degrees, Fahrenheit, then roasted by a combination of coils and infra-red lamps at the rate of a pound in about two minutes. The roasting is ended automatically by a photo-electric device that measures reflected radiations from the coffee beans—green coffee beans are good reflectors, roasted beans very poor ones.

Advantages claimed are that by buying blended green coffee and roasting it himself, the grocer can lower current retail coffee prices, consumers will get fresher coffee, and they will buy more of it at the lower price.



Two minutes average roasting time



Uniform flame mass shows efficient combustion with new head



Old type combustion head gives ragged flame, is inefficient

PETROLEUM

Conducted by E. F. LINDSLEY

Fuel Oils Have Changed

Not so Dramatic as Some Petroleum Developments, but Holding a Vital Interest for Oil Heat Users, is the Current Transition to Better and Somewhat Different "Cat-Cracked" Fuel Oils. Efficient Heating Will Depend on Proper Adaptations of Present Burners to a New Oil "Diet"

By WILLIAM A. SULLIVAN

Senior Applications and Development Engineer,
Manufacturing Department, Shell Oil Company, Inc.

CATALYTIC cracking, a comparatively new development in oil refining, has caused a minor revolution in the fuel-oil business. While straight-run and thermally-cracked distillates supplied the entire fuel-oil requirement before the war, "cat-cracking" now provides much of this gallonage, and seems destined to produce an ever larger share in the future.

Straight-run refining takes out of crude oil, by distillation, only those chemical compounds present in the oil when it came from the ground. Thermal cracking is an improvement on this. By subjecting crude oil to intense heat or to combined heat and pressure, it breaks down

the more complex molecules originally present into simpler ones; in other words, it re-forms the original chemical compounds into new compounds to get a larger yield of the products most desired.

"Cat-cracking" is an elaboration of thermal cracking. Oil is cracked in the presence of a catalyst—such as certain compounds of manganese, iron, aluminum, and silica—to produce either different arrangements of molecules than can be had by thermal cracking, or to produce the same arrangements at different temperatures and pressures. The process reached a high stage of development during the war when it was responsible for turning out

enormous quantities of high-octane aviation gasoline, and for every gallon of "cat-cracked" gasoline produced, an approximately equal volume of fuel-oil distillate was turned out.

To answer the questions regarding this war-time fuel oil with respect to the operation of both pre-war and future oil burners, extensive investigations have been carried out at Shell's Sewaren Fuel Oil Laboratory.

BURNER TESTS—Here, before the development of catalytic cracking reached commercial production, engineers and petroleum chemists engaged in thorough experimentation with "cat-cracked" fuels to find the answers to these questions. Many varieties of the fuel, produced under different operating conditions in refinery pilot plants and in commercial units, were tested in the laboratory. These findings were checked against the results of a year of field experience, in

• LOOKING AHEAD •

More research on oil heating problems to come... Closer matching of burner designs and fuel characteristics... Cleaner operation at higher levels of efficiency... Lower fuel consumption with better fuels... More general understanding of burner installation fundamentals... Wider industrial use of oil heat.

which the marketing organizations checked the reaction of consumers to millions of barrels of "cat-cracked" fuel distributed throughout the country.

Results of these tests offered substantial evidence that "cat-cracked" fuels are superior in many respects to the thermal-cracked and straight-run distillates of which pre-war fuels were composed, and that they may actually accelerate the greater acceptance of oil as an economical and satisfactory form of heat.

One important factor is that cata-

tendencies toward corrosion of metallic oil-burner parts, such as copper lines, pump seals, and pressure-regulating valves. Their difference from many pre-war and war-time fuels in this respect is apparently due to the fact that corrosive compounds which may be present in feed stock are either removed during the cracking or subsequent treating processes, or are chemically converted to non-corrosive forms.

The impression has become rather widespread that catalytic fuels are much heavier than pre-war fuels. In weight per gallon this is true, they weigh more than straight-run distillates of comparable boiling range. But this is actually a distinct advantage because the heavier the gravity of the fuel, the higher its heat value. In viscosity, the most reliable measure of the ease with which oil can be atomized, the difference between catalytic and straight-run fuels is negligible; catalytic fuels are lighter, if anything, in this respect.

In pour point, due to their higher

aromatic content and lower paraffinity, catalytic distillates run lower than their predecessors. This is still another point in their favor, since it makes for easier handling in extremely cold weather.

AIR-OIL MIXING—Actually, catalytic distillates rate lower than pre-war fuels in only one respect. Under adverse burning conditions, they show a somewhat greater tendency to smoke and carbonize than straight-run distillates in the same boiling range. It should be noted that this is under adverse burning conditions. In heating apparatus that provides proper burning, catalytic fuels exhibit no greater tendency to smoke than straight-run fuels.

The petroleum engineers offer the following explanation for this. Burning the high proportion of aromatics in catalytic fuels involves splitting apart the carbon and hydrogen and burning each element separately. Unless each carbon particle thus liberated is surrounded by air while still at high temperature, it escapes without being burned and appears as smoke, soot, or carbon. Catalytic fuels, hence, require more thorough mixing with air than some fuels to completely ignite all the free carbon split off during the combustion process. In general, more efficient mixing of air and oil is the basic issue around which revolve almost all adaptations of the fuel to existing burners and the design of new burners.

Tests conducted on vertical, rotary-wall flame burners, for example, have demonstrated the important role timing plays in mixing air and oil when burning catalytic

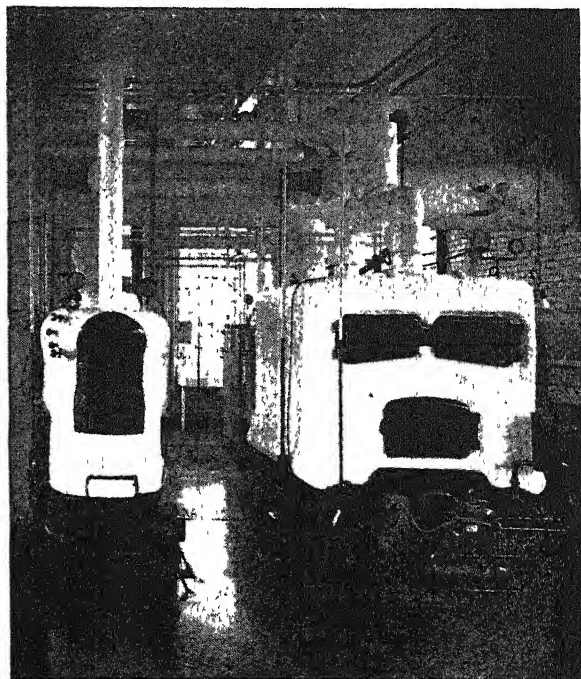
Combustion head installed in blower mouth. For best efficiency, relative positions of oil nozzle, flanges, and blower mouth are mutually adjustable.



lytic distillates are inherently cleaner and less likely to deteriorate and form sediment in storage than many untreated straight-run distillates and the average thermally-cracked distillate. This is because catalytic cracking produces a relatively high percentage of aromatic compounds, considered the most stable of the four hydro-carbon groups. The small percentage of remaining unstable constituents responds quite readily to removal by acid treatment. When the increasing industrial and domestic use of oil burners is considered, this factor of cleanliness becomes a particularly welcome improvement. In the case of domestic units, burners must operate at relatively low firing rates and are more susceptible to clogging of the atomizing nozzle or oil-metering valve than the larger industrial sizes.

Catalytic fuels have shown no

Portion of oil-heat research and testing laboratory. New fuels, new equipment, and wider use of oil heat have posed a variety of questions answerable only by service-type tests.



fuels With low-type grills clipped on the edge of the flame rim, there was a limit to the amount of catalytically-cracked fuel that could be blended with a straight-run distillate without producing excessive smoke and forming a heavy carbon build-up on heating surfaces at the base of the boiler. By simply raising grills about two inches above their normal setting, however, thus affording a slightly longer time for mixing air and oil before combustion, it was possible to burn 100 percent of catalytically cracked fuel without a trace of smoke and without objectionable carbon formation, over a prolonged period of operation

Increasing the diameter of the fan also gave marked improvement in performance of vertical, rotary burners on catalytic fuels This produced a higher velocity air stream, which provided greater turbulence and more intimate mixing of air and oil in the early combustion stages.

In both cases, these were relatively simple changes, but still sufficient to bring burning conditions in line with fuel requirements, just as retarding the spark timing in an automobile engine suppresses the tendency of gasoline to knock Indeed, the two phenomena appear to be closely related

Improved performance of both catalytic and pre-war fuels can be obtained from the gun-type burner by closer control of the air-fuel mixture. The largest percentage of all smaller burners are of this type, and, taken as a whole, they are less critical to the composition of the fuel than any other burner.

In most cases, the tendency of catalytic fuels to smoke can be overcome in gun-type burners by simply opening the fan shutter and supplying more air This is the easy way out, however, and not necessarily the most desirable. While the oil will burn completely this way, the heat produced is wasted in heating excess air. Thus gains that should be realized from the higher heat content of the catalytic fuel are nullified.

COMBUSTION HEADS—In making a special study of the problem, it was found that the design of the combustion head or air turbulator was the most important single factor influencing gun-type burner efficiency. By designing the mixing head so as to maintain high velocity air at a point where it enters the oil spray, an intimate air-oil mixture could be obtained without greatly increasing the volume of air beyond the theoretical amount required to burn the oil. By this means, it was

possible to burn a 100 percent catalytically-cracked fuel with no smoke whatever, and with a practically negligible loss of heat through excess air

This new combustion head, designed at the Sewaren laboratories, is now being licensed to burner manufacturers who wish to incorporate it into their own design, and, in addition, research is underway to investigate the possibilities of adapting it to existing gun-type burners already installed

Fifteen years ago, the petroleum industry thought of sales chiefly in terms of gasoline. Fuel oil was a minor by-product that received scant attention. Today the demand for fuel oil has skyrocketed to such proportions that it has taken its place along with gasoline as a major product of refining. Annual consumption in the United States is in the billions of gallons, and is constantly on the increase.

Although straight-run and thermal-cracked distillates, each with their own special merits, will continue to supply much of this demand, there is little doubt but that the trend is in the direction of more and more catalytically cracked fuels. As time goes by, adaptations to existing burner installations, and completely new designs in burners, will enable the industrial and domestic consumer alike to obtain the maximum benefits from it.



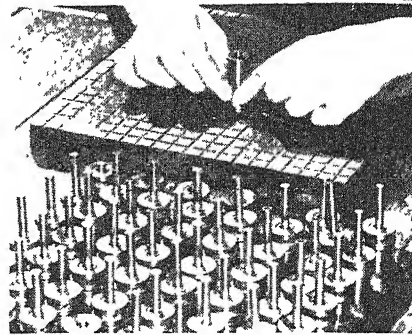
FUEL CONTROL

Gives Improved Diesel Performance

IMPROVEMENT and refinements in the fuel injection system of the modern Diesel engine are responsible for its versatility, according to Ralph L. Boyer, chief engineer of The Cooper-Bessemer Corporation

In the Cooper-Bessemer fuel injection system, component parts are lapped and fitted to within 25 millionths of an inch. One such part is a plunger that fits into a small cylinder through which fuel oil is pumped into the engine cylinder for combustion. The reason for such precision is that this heavy fuel oil is pumped at a pressure of from 7000 to 10,000 pounds per square inch, and any appreciable leakage would be greatly magnified by the terrific force.

The oil is pumped through the system to an injection spray nozzle about the thickness of a lead pencil. At the tip of the nozzle there is a



Diesel fuel injector bodies and stems must be precisely lapped or polished

ring of from six to ten holes, each one drilled individually to a diameter of .008 inch, and each one drilled at precisely the same angle to assure uniform injection. On this exact uniformity depends the efficiency of the entire power plant, for if the fuel oil does not enter the cylinder as a fine fog which can be completely burned, power is lost and "knocking" can be expected

POUR POINT

Depressed, Viscosity Index Raised by Oil Additive

IN TENDED for wax-base lubricating oils, a new material not only lowers the pour point of many oils effectively but also retains the reduced pour point under cyclic temperature changes Paraffin-base motor oils in the SAE-10 and SAE-20 range which show a tendency to revert to their original pour points with some additives, are reported to be effectively stabilized with Acryloid 150 Stable pour points as much as 40 or 50 degrees, Fahrenheit, below the original pour point are claimed to be obtainable.

In addition to its characteristics as a pour-point depressant, Acryloid 150 is also described as an effective viscosity-index improver Thus it is possible to raise the viscosity index appreciably and at the same time lower the pour point with the addition of this material. It is suggested that a refiner might, therefore, cross-brand oils, producing an oil which will meet both SAE 10-W and SAE-20 specifications

The developers, Rohm and Haas Company advise that Acryloid 150 be used in quantities of about 1 percent and that it is readily blended with mineral oils by any of the commonly used methods. Since the material is supplied as a fairly viscous product it is desirable either to heat the Acryloid to about 150 degrees, Fahrenheit, before adding, or to heat the entire blend after the addition of the depressant. Mixing is ordinarily accomplished by circulating pumps or paddle stirrers.

Machine Tools For Heating

• LOOKING AHEAD •

An increasing number of "punched-out and brazed-together" articles... Fewer fatigue failures with selective-area heat treating... Faster machining with heated metal will be a boon to cost-conscious industry... Longer wear from bearing surfaces... Less internal-strain distortion of precision parts... Automatic controls will eliminate variations between heat-treat batches.

IN PLANTS all over the country several different types of machine tools are starting all-out races for the right to perform industrial heating jobs.

The competing machines are being mounted beside each other, sometimes on a winner-take-all basis, more often with the idea that each shall take over such tasks on the production line as it proves itself best able to perform.

Guiding every move on each machine are staffs of the keenest brained application engineers that industry can produce. College professors are being lured from their lecture platforms to get out into the factories for a few days at a time and apply the latest heating theories. Technical and business men are watching every improvement in their own and competitors' machines, working intensively, seven days a week to apply new equipment, thinking and experimenting.

The stakes are big. Winners will make huge installation sales right now. And they will have the right to go out and use every success as a sales argument all over the world.

Sitting on the benches and waiting to get into the game in some cases, carrying the ball and playing a stellar role in others, are the makers of chemicals and of equipment for de-scaling, the designers of all kinds of production tools and equipment, the makers of every

To Apply Heat Where and When Wanted, and in Exactly the Right Amount, Has Long Been a Dream of Metal-Working Industries. Now, Contoured Ceramics, High-Frequency Currents, Controlled-Atmosphere Furnaces, and Molten-Salt Baths Give Precision to Heating Processes

By EDWIN LAIRD CADY

kind of metal and other raw material. This is a contest the like of which has not been seen since the days nearly 40 years ago when high-speed steels and production-grinding machines almost simultaneously made their first major impacts on the production lines. No one knows what the ultimate effects upon all kinds of industry will be.

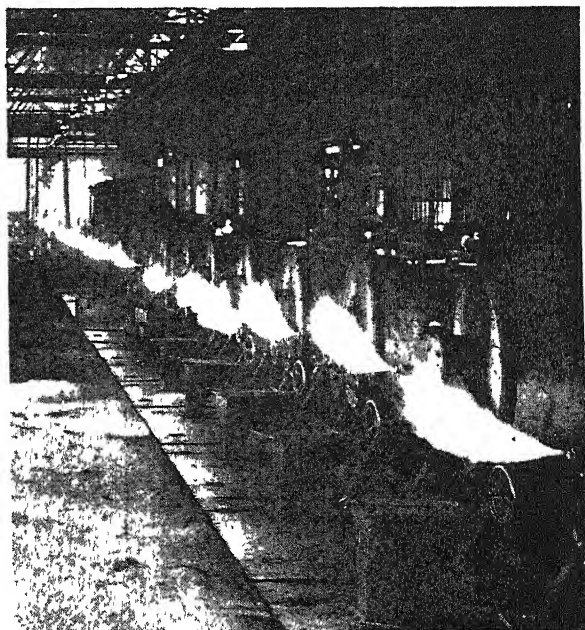
CERAMIC HEATING—One of the entries is so wholly new to most production men that very few other than its own engineers have any clear idea of what it can do. It works by first pre-mixing air and combustible gas, putting this mixture under carefully controlled pressure, then feeding the mixture to specially shaped ceramic surfaces.

Once they are warmed up, the ceramic surfaces supply radiant

heat which not only helps to heat the work but also promotes combustion of the gas and air mixture and makes it easier to keep the amount of combustion heat under exact control. The contours of these ceramics are shaped as accurately as those of precision dies. They direct the heat so that it follows the contours of the work pieces and is applied, heavily in one spot, more lightly in another, just as it is wanted along the work surface.

These machines can heat selected areas of pieces, or whole pieces, as desired. They use automatic timing devices, materials-handling mechanisms, and quenching means as needed. In operation, the work piece advances to the heating zone, is positioned at an exact distance from the ceramic surfaces, turned if necessary, then with split-second timing is moved to the quench tank.

A battery of gas-fired heat-treat furnaces. Here low cost, long-known practices, and wide acceptance have combined with modern de-scaling techniques to give the simple type furnace a fighting position among newer heating tools.



or other cooling zone. Ceramic heating saw extensive application during the war and is currently invading many fresh fields.

H-F HEATING—Induction-heating machines are racing for the same controlled-area heating market, and have a long head start for it. These devices take alternating current—direct current may also be used—at the standard 60 or other cycles used in the plant, employ rotary converters or various kinds of electronic circuits to step up the frequency to anything from 3000 to 50,000,000 cycles, and pass these high-frequency currents through “inductors” or work coils. The work goes within the coil but is carefully kept from touching it. Magnetic flux from the work coil passes across the narrow air gap to the work itself and sets up eddy currents which reverse their directions within the work piece twice as many times a second as the current has cycles. These eddy currents or circuit “losses” cause the work to heat up.

Induction heating engineers’ design and shape the work coils as carefully as the gas-ceramic machine manufacturers do their ceramics. The timing, positioning, work handling are just as exact. Between these two it is a tool-makers’ contest. Both methods really proved themselves for the first time during the war. Induction heating was 10 years old when the war began, but with the exception of a few automobile and other large plants very few engineers knew much about it. Installations were few and on many war jobs induction heating was able to perform its production miracles only after application engi-

neers had sweated over it for a year or more. But it came out of the war as a proved production tool with capabilities and techniques so well known that now single installations costing as much as \$500,000 are being made. Its peace-time market is at least 20 times as large as its war-time one.

FURNACES FIGHT BACK—The induction-heating and the gas-ceramic machines use high heating speeds, especially for local-area heating, to avoid scaling the metal. They move their work pieces into and out of the heating zones with a series of quick movements interspersed with carefully timed pauses for heating.

Working right beside them are controlled-atmosphere furnaces. Through these the work pieces move in steady streams. Timing is exact, work-handling mechanisms are well thought out, but selected-area heating is difficult if not impossible. Thus the contest between a furnace with the work moving slowly and steadily and two machines in which the work jumps quickly and then pauses becomes that of a tortoise *versus* two hares of different breeds.

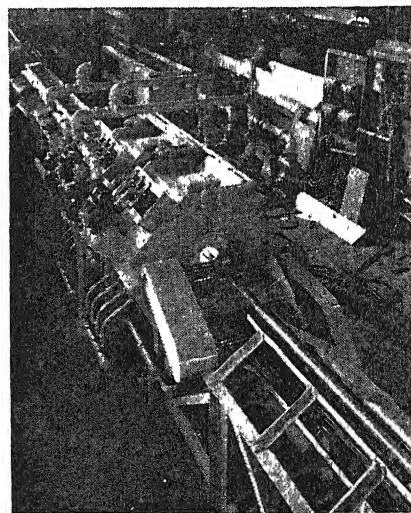
The older style furnaces which use atmospheres that are controlled very little, or not controlled at all, are by no means out of the running. They can set up scale losses which amount to as much as 3 percent of the metal heated. But they are by far the least expensive to operate. They cost less per ton of heating capacity to install. And with such processes as sodium-hydride de-scaling available, the amount of loss to scaling is reduced to the actual scale produced in the

furnace, there is practically no additional loss of metal to pickle baths.

Makers of metals-cleaning compounds are bolstering the case of the open-muffle furnace and all kinds of open-fire heating. Their products can take off the scale from most metals, and leave clean and corrosion-resistant coatings behind them. And the open-muffle furnace has the advantage of years of use in factories. Everyone knows how to use it.

MORE TO COME—Just nosing its way into this contest is the modern salt bath. Here, the temperature can be controlled with greater accuracy than in any other device. No one can even guess what salt baths will be accomplishing when the chemists have developed the salts a little further. Right now, the most exactly controlled hardening, much de-scaling, and even some soldering and brazing in which the pieces are heat treated while being fastened together, all are being done in salt baths.

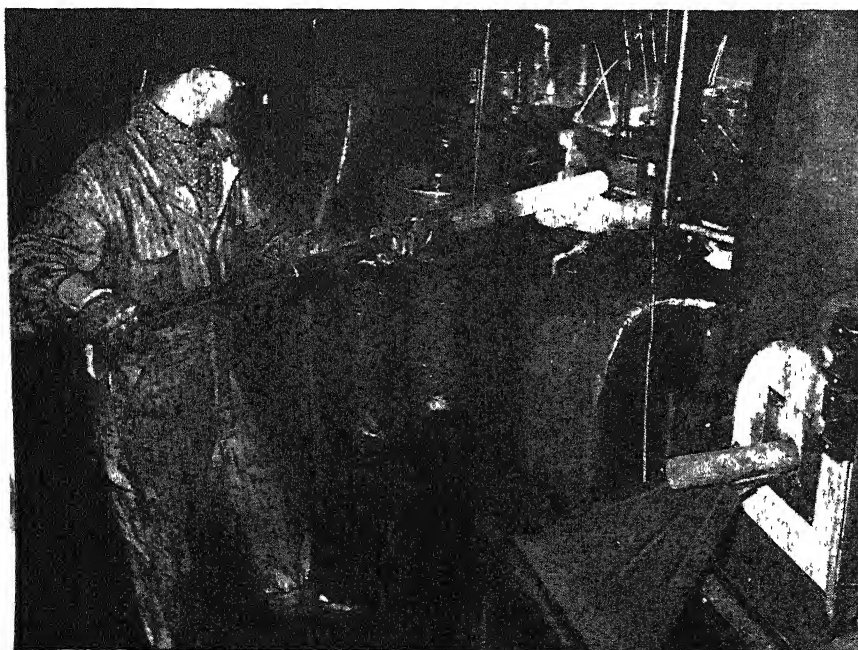
The production manager, then, has a great deal to watch as these gas-ceramic, induction-heating, controlled-atmosphere furnace, open-



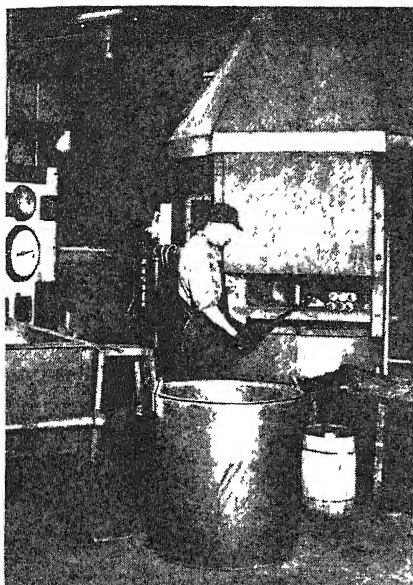
Ceramic-furnace unit is a product of exact design for exacting heating jobs

muffle furnace backed by modern de-scaling, modern salt bath, and many other heat-treating machine tools compete for places on his production line. Some of the things that will happen are sure to be almost revolutionary.

Soldering and brazing operations will become fully mechanized as never before, and more of them will be performed than ever before. Dozens of new silver solder, braze, and soft-solder alloys, and better fluxes, will be worked out to fit the new mechanical techniques. All such jointing alloys will be cut to size and perhaps stamped to shape, or



Induction heating, one of the foremost contenders for selective-area assignments



Controlled atmosphere furnaces demand precision controls Note panel

will be in liquid or plastic forms but be fed in exactly controlled amounts to exactly designated areas. The forming and placing of solder and braze alloys will become a new mechanical art with specially developed equipment. The contours and tolerances of the parts to be joined will be maintained far more exactly than they are now, with operations of punch presses and other machine tools affected accordingly. Another brand new mechanical art will be developed for rapid positioning of the parts to be joined and for holding them in position during the heating operation. Most of the new equipment for soldering and brazing has not yet reached the drafting-board stage.

SELECTIVE-AREA HEAT—As a result of these developments, there will be much swapping of positions between high-alloy and low-alloy metals.

Low-alloy steels and other metals can be so hardened on selective areas that they have the wear resistance of present high-alloy counterparts. The savings by substituting the low alloys will be in metals and in machining costs.

By contrast, selective-area hardening often can save enough on the heat treating, the straightening, the secondary grinding, and other production costs so that it pays to use higher-alloy metals.

In between the high and the low are wide ranges of medium-alloy metals. These will take over assignments from both ends of the range.

Selective-area hardening and annealing, and far wider selectivity of what may be brazed or soldered, are resources which the stress engineer has long awaited. With them,

machine parts can be so designed that the stresses concentrate in the places where they can do the least damage. Sprocket and clutch teeth, for example, can be so hardened that most of the tensile and shearing stresses are transferred by the stiffened teeth to the resilient and unhardened masses of metal below the teeth. When this happens, a highly stressed part can be made 20 percent or more lighter and still have far more durability than the original.

By annealing selected areas of parts and leaving the remainders hard, the parts can be straightened far more rapidly. Some areas can be stiff to withstand chuck-jaw pressures while others are softened for machining. All sorts of new parts can be made by simple twisting or bending of pre-formed shapes, the areas from and to which metal will flow in drawing-press dies can be so controlled that stronger and better parts are made with lower die and fabrication costs.

MAGIC TEMPERATURES—Carbon steels are much stronger at about 600 degrees, Fahrenheit, than at room temperature. Many machining operations, especially on bars of less

than a half-inch diameter, now have to be slowed down to prevent the steel from springing away from the tool, from tearing, or from twisting off. The attachment of selective-area heating devices directly to machine tools will permit the machining of this steel at a temperature which gives the greatest mechanical strength, with machining speeds which are undreamed of today.

Various alloys of copper, magnesium, aluminum, and other metals have their individual "magic temperatures" at which they can be machined, drawn, spun, stamped, or cold forged far more easily than at any other temperatures. At present, these temperatures are listed among the known facts which are impractical of application. The modern machine tools for heating will change all that.

The race is on, then, to see which machine tools for heating will be quickest and best in the business of bringing hundreds of benefits to industry. And the integrating and mechanizing of heating devices to the point where they can be regarded only as machine tools is the most promising as well as dramatic fact in the mechanical engineering world today.



STEEL WOOL

*Now Made from Stainless
To Gain in Quality*

IN MODERN industrial processes, steel wool is clamped between disks to form buffing and scouring wheels, is formed into balls and cones which can be mounted in drill chucks, and is used by many another power driven method.

Industrial steel wool needs several controlled qualities. Sharpness of the edges of individual strands, freedom from saw teeth on those edges, controlled amounts of resiliency, and resistance to damage by fatigue failures of the strands and by corrosion, are among them.

To obtain increased amounts of these qualities, industry is turning to steel wools made of alloy steels. Stainless steels are increasing in use for this purpose. The stainless steels are strong, take edges which are sharp and durable, and, of course, are highly resistant to corrosion.

MACHINE SCRAPS

*Melt Without Burning
In Electric Furnaces*

THE OLD-TIME foundryman's dream was to melt scrap chips taken direct from the machine shop. Unfortu-

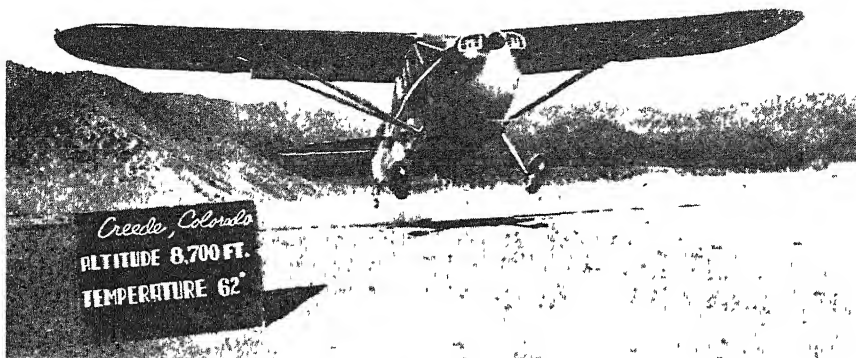


Foundry furnace salvages scrap

nately, chips burn up in ordinary cupolas.

Modern electric furnaces protect the chips against excess air, can melt the chips in inert-gas atmospheres if necessary. In them, the scrap can be carefully mixed to control the alloy ingredients.

Often the presence of such a furnace in a foundry connected with a machine shop can melt scrap at high enough savings to mean difference between profit and loss on the machining of alloy steels,



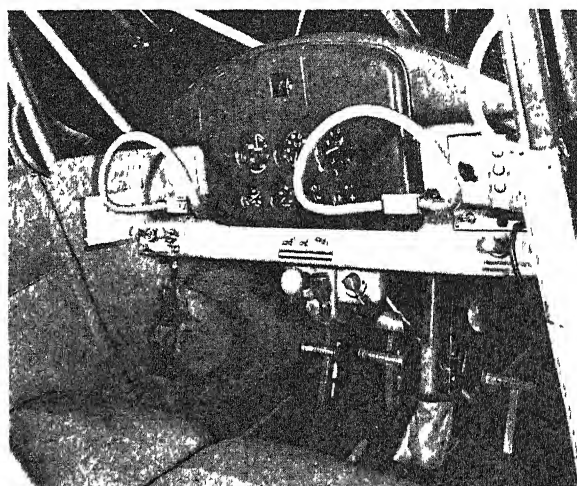
Courtesy Stinson

Rapid take-off, fast climb are vital to safety, make smaller fields practical

Convenient and correctly designed control handles contribute to comfort and security of private pilots. Also shown in the photograph below is the clean, smooth instrument panel in a Stinson Voyager 150. Such panels are not only attractive in appearance but are an added safety feature in case of an accident.

AVIATION

Plane Sense and Safety



Analyzed in Terms of Accident Causes, Private Flying's Safety Record Clearly Shows the High Price of Recklessness. Sane Flight, However, is Relatively Safe. In a Determined Effort to Cut the Toll, Government and Industry Now Combine in an All-Out, Safe-Flying Campaign

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

THE future of private flying seems assured. Plane designs are excellent; manufacturers have thousands of orders on the books; learning to fly is easy; aviation is expensive but not too expensive; and great numbers of people have both the money and the desire to engage in private flight. One less sanguine factor remains—the poor safety record of private aviation.

Mr. Jerome Lederer, Chief Engineer of Aero Insurance Underwriters and a recognized authority on aviation safety, takes a frankly pessimistic view. In a speech before the Private Flying Conference of the National Aeronautic Association,

Mr. Lederer said. "In the past 15 years I have tried every means . . . to get pilots, mechanics, airport operators, and other aviation enthusiasts to adopt safe practices. The figures show that my efforts and those of others have failed miserably. Before the war, in the worst year, about 40,000 people were killed on the highways. If there were as many aircraft as automobiles, the yearly aviation death rate would not be a mere 40,000 per year but 250,000!"

Unfortunately, sound statistics support Mr. Lederer's comments. An accompanying table offers the comparative safety record, as pre-

sented by the National Safety Council, based on the average figures for 1939 and 1940; the last two years for which valid aviation records are available. In this analysis, drivers of passenger automobiles and pilots of private planes are considered passengers.

Regular transport flying is safer than the automobile, though it does not make quite as good a showing as the railroads. But the figures for private flying are deplorable! Actually, private flying should be nearly as safe as transport flying. It is not the intrinsic character of private flying which makes it hazardous. It is a neglect of safe practices, plus low stunting and reckless flying, which mar the situation.

In one week, the Civil Aeronautics Safety Board reported five light-plane accidents in various parts of the country. Each of the five accidents was due to reckless flying or poor piloting. Some of the CAB reports read: "Poor piloting,

• LOOKING AHEAD •

For a while, a continuance of private aviation accidents as more and more people fly. . . Later, a growth of public indignation, even more strenuous safety campaigns by all concerned. . . Eventually, general realization that flying is not quite so simple as motoring. . . This, followed by better safety records as air lore becomes common knowledge to new generations.

pilot stalled out of the turn at low altitude" another "probable cause of the accident was the pilot's maneuvering of the aircraft at a recklessly low altitude" . . . and yet another "pilot failed to keep the engine warm in a long gliding descent."

Another tabulation of statistics on fatalities, printed here, confirms the view that with reckless flying eliminated, the safety of private flying would be immeasurably improved.

ACTION DUE—In an effort to eliminate reckless flying, an energetic educational campaign is being conducted under the joint auspices of the National Aeronautics Association and of the Aero Insurance Underwriters. As a beginning, an advisory council of 17 interested national organizations has drafted the minimum standards to determine the eligibility of airports for certificates of good safety practice.

The second part of the safety campaign will comprise a series of monthly educational drives, each directed at one phase of the safety problem such as reckless flying, collision hazards, inadequate flight planning for cross-country trips, accident prevention, and the like. Piper Aircraft Corporation is also sponsoring a nation-wide contest to encourage safe flying by students, pilots, and plane owners, with a flying log and freedom from accidents as the basis of awards.

Although the exact details of the NAA Educational Campaign are not yet available, there are some things at which it will certainly be directed. One is the pilot who is a public nuisance and disturbs people by low flying, with or without acrobatics. Such pilots should be reported. Fire hazards such as arise when pilots throw burning cigarettes out of a ship; low stunting; spectacular takeoffs; inaccessible fuel strainers; dirty fuel; and improper cockpit vision are other dangers whose miscellaneous natures are in themselves indicative of the prob-

lem's magnitude. Airport managers as well as pilots bear a heavy responsibility and among other things should make provision against trespassing by people who may damage airplanes with the damage remaining unnoticed until too late.

Private flying safety is not a matter of one device or one outstanding invention. It is a combination of safe practices in the air and on the ground.

REGULATIONS—The Civil Aeronautics Board quite rightly believes that safety observance in general lies well beyond the imposition of regulatory requirements. W. E. Konecny of the CAB Safety Bureau concurs fully with the views of NAA and does not believe that Civil Air Regulations should try to cover all safety problems. "There remains

Passenger Deaths in 100,000,000 Passenger Miles

Automobiles and Taxis	32
Buses	0.22
Railroad Passenger Trains	0.24
Scheduled Air Transport Planes	24
Privately Operated Planes	768

unregulated by CAB a broad field dealing with safety which can be dealt with more efficiently by other than regulatory means." There are many practices to this end which should be observed by pilots; other which should be followed by manufacturers and ground personnel.

Pilots, to get a private flying certificate, need only 30 hours solo, three hours cross-country experience, 10 hours dual instruction, and a written examination in Air Regulations. Safe pilots, however, recognize the limitations of this rudimentary knowledge; they study meteorology, acquire some knowl-

edge of cross-country navigation and gain some grasp of maps and topography. Above all, pilots should know when *not* to fly. According to Mr. Konecny, "The experienced pilot who might be able to cope with an emergency under adverse conditions is the one who usually has learned by that very experience when to stay on the ground."

SAFE PLANES—The designer and manufacturer of the airplane itself also play a part in the safety picture. The importance of stall- and spin-proof planes, of planes provided with a nose wheel, of simplified two-control designs cannot be overestimated. But there are many other more prosaic features that the designer must keep in mind. Private airplanes need a rate of climb well over 300 feet per minute, a climbing angle of at least 1 in 12. If the ship is to be used for cross-country work, then the fuel tanks should have at least one gallon capacity for every seven horse-

Statistics of Fatalities in 1941

Cause	Number of Accidents	Fatal
Low Acrobatics	20	16
Circling Houses, etc	6	5
Stalls Near Ground	20	17
Others	6	6
Total	52	44

power of the engine. The recommended cruising speed should be low enough that the engine is not pushed too hard on prolonged trips.

Low landing speed is important, but it is even more important that the pilot have ample control at the slowest flight speed. Here the airplane must be both stable and easily controlled. Windshields of the non-



Range of 600 miles and wing slots are Skyraider safety features

splintering type—proof against the impact of a bird—are as vital in planes as they are in automobiles. Furthermore, windshield defrosters, and wing de-icers have a definite role in safe flight.

A wide variety of minor details enter into design considerations of safety. For example, door handles should be jam-proof, control handles ought to be of distinctive shape so that in an emergency the pilot can pick out the correct handle by feel, and protruding objects within the cockpit should be avoided. An instrument panel with many knobs protruding from it may cause serious injury in a crash landing where—as a flat instrument panel may act as a shock absorber.

All of the foregoing factors—government and industry campaigns, better plane designs, and a sounder grasp of flying fundamentals by pilots—will ultimately aid the cause of private aviation safety. As with most problems where the public safety is involved, however, a purposeful action by the general public will be required if a level of adequate safety is to be reached. Purchasers and users of private planes can accomplish a substantial amount along these lines by abstaining from foolish practices themselves and upholding the Civil Air Regulations. Even non-flyers may do their share by promoting the construction of air facilities in their home communities; and, equally important, by exercising their rights as citizens in seeing that such publicly sponsored facilities are well managed by sensible and competent personnel.

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WIND TUNNEL

*Provides Test Conditions
For Engines and Propellers*

PERHAPS the most versatile wind tunnel ever built is that recently announced by United Aircraft Corporation. While many industrial wind tunnels have been built for general aerodynamic testing, this industrial laboratory is the first to be built solely for power-plant and propeller testing. The east leg of the tunnel has a closed-circuit length of 634 feet, with fan-motor foundation and maintenance hoisting equipment on one side and air exchanger towers on the other.

Two alternate test sections can be put to work. One has a throat diameter of 18 feet, in which speeds up to 200 miles per hour can be obtained; the other with a throat diameter of only eight feet, with available air speeds up to 800 miles per hour. It is this interchangeabil-

ity of throat sections that accounts for the versatility of the new piece of equipment.

The propeller, 26 feet in diameter, has 20 blades and is variable in pitch. Back of the propeller are air-straightening vanes.

Wind tunnels have now reached a high degree of complexity and need many auxiliary devices. In the United Aircraft tunnel, models can be mounted on a turn-table for obtaining data on yawing and pitching. Test models are supported on a six-component balance frame which measures thrust up to 20,000 pounds.

Since the laboratory is designed to function at constant temperatures, two air-exchanger towers are provided, each 66½ feet high, through which warm air is exhausted and fresh air is inducted. A large air-exchanger capacity is indispensable because a powerful engine under full load must dissipate a tremendous amount of heat energy, and to this has to be added the 7000 horsepower of the ventilating fan.

Special equipment is available for testing small propellers, fans, and helicopter rotors.

AIRCRAFT SOUND-PROOFING

*Improved by Newly
Developed Material*

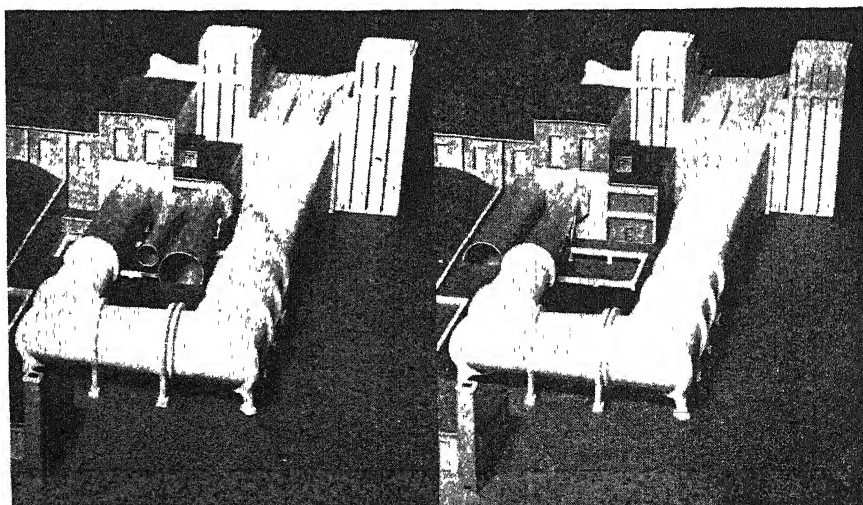
SPEED and power of aircraft have greatly increased in recent years, and noise has increased accordingly. But noise reduction within the airplane usually involves some loss of performance, either from the additional weight of sound-proofing material or from the loss in engine efficiency due to an exhaust collector system.

Now that emphasis has shifted once again to civil aircraft, greater efforts are being made both in reducing the noise at the source and in sound-proofing. Moreover, a new

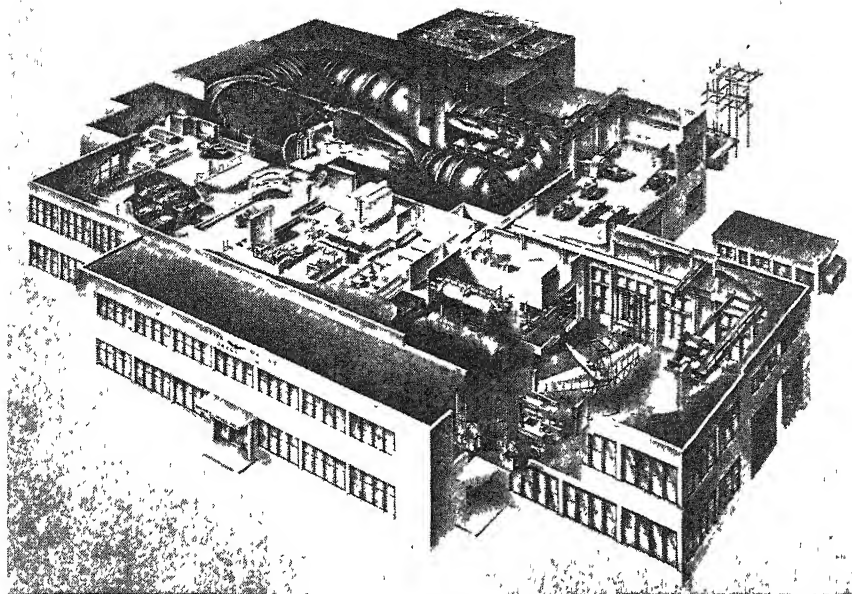
problem arises as the jet engine appears likely to be employed in commercial aircraft. In the jet engine the main sources of noise are the whistle from the impeller and the roar of the jet. The use of the jet engine avoids the use of a propeller, but, of course, the jet cannot be muffled. Some authorities are of the opinion that, for the same performance, aircraft powered with jet engines may be less noisy than those powered with piston engines with open stub exhausts, but the exhaust noise of the piston engine may be reduced by manifolds; thus the question remains to be answered and further research is necessary.

In the meantime, one of the most important things is to give the greatest attention to sound-proofing materials. It is possible to secure sound-proofing from non-porous solid slabs or panels simply by the sheer-bulk method of increasing their thickness and weight, but that is an unsatisfactory solution to the airplane problem. Better sound insulation for a given weight is obtained by inserting a layer of light, porous, sound absorbing material in the space between the outer skin and the lining. Double windows also help.

The Electro-Acoustic Laboratory at Harvard University, which has done much research for the AAF to reduce noise inside long-range bombing planes, has tested many materials and now announces as a proved fact that an acoustical material for aircraft use should have a large surface area of the fibers in proportion to their weight. Owens-Corning Fiberglas Corporation has developed a material in accord with this finding. Called Fiberglas insulation, it is composed of glass fibers with an average diameter of 0.00005 inch, which are



Wind tunnel model shows method of alternating test sections by moving throats to side. (Left): Large section in position. (Right): Eight-foot throat installed



Cutaway view of aviation research laboratory indicates the wealth of complex equipment involved. Wind tunnel, model shop, and altitude chamber are visible.

treated with a thermosetting binder and shaped into resilient, flexible, half-inch-thick sheets. The density is only 0.6 pounds per cubic foot, while that of water is 62½ pounds per cubic foot. The approximate weight of the sheets per square foot is 0.025 of a pound. Put more graphically, a thousand square feet of the material, as produced in half-inch thickness, weigh no more than a suitcase packed for a week-end trip.

Thermal conductivity is also low so that thermal as well as acoustical insulation is obtained. Tests made with two half-inch layers of the material with an asbestos septum between them, and faced on one side with trim cloth, have shown that the material is very much better proportionately to its weight than the ordinary weight-law of acoustical insulation would indicate. Applications of the new material are possible not only in airplanes but also in automobiles and trans.

AVIATION LABORATORY

*Is Turned to Academic Uses
When Plane Company Moves*

WHEN Curtiss-Wright moved its airplane plant to Columbus, Ohio, it transferred its aeronautical research laboratory at Buffalo to Cornell University. Finances and research problems for the laboratory are supplied by a group of eastern aircraft manufacturers. Fully available to graduate students will be a new 600 mile-per-hour wind tunnel, of the return or closed circuit type; a model shop; chemical and metallurgical laboratories; and an altitude pressure chamber. In the latter,

altitudes up to 80,000 feet and temperatures as low as minus 85 degrees, Fahrenheit, can be simulated. Another fine piece of equipment is a system whereby an airplane instrument panel can be observed by television at a ground station. Particularly important, many of the laboratory personnel, including its Director, Doctor C. C. Furnas, will remain.

PRODUCTION "PACKAGE"

*Speeds Construction
of New Aircraft*

MANY war-learned lessons in the mass production of aircraft are now finding application both in peacetime aviation and in planning a system of production-preparedness for the future. When early hand-methods of aircraft construction gave over to mass production, it was considered necessary for an airplane to pass through multiple stages before quantity production. First, the plane had to be designed on an experimental basis; next, two or three were built for service testing; and finally it was necessary to redesign before it was safe to tool up for mass production.

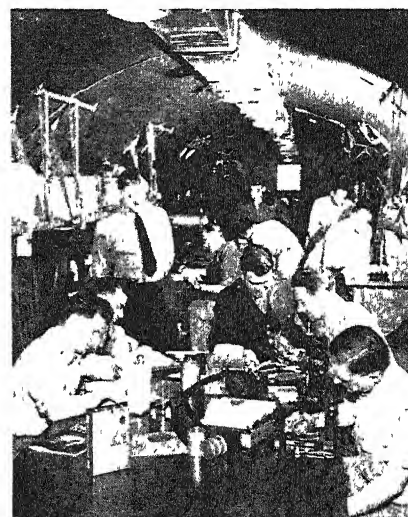
Richard S. Boutelle, Vice President and General Manager of Fairchild Aircraft, writing on a "Key to Preparedness for Mass Production" in *Pegasus*, summarizes a great deal of the aircraft industry's cumulative production thinking in terming a new principle—that eliminates the multi-stage development engineering—"packaging" mass production knowledge. In his discussion of the "packaging" principle, as applied to the building of the Fairchild Cargo Packet, Mr. Boutelle tells of collect-

ing all production knowledge, investigating tooling, and formulating jig designs while the plane was still in the design stage. Under this plan, successful prototype tests were not the signal to start production thinking, but were, instead, the authority to speed the "package" of production knowledge to the production-lines. Hence, construction in mass quantities got under way many months earlier than it would have under previous procedures.

LABORATORY PLANE

*Carried Researchers
to Pacific Islands*

DURING the war in the Southwest Pacific, the Army's Tropical Science Mission converted a Douglas C-54, four-engine transport, into a flying laboratory. The C-54 laboratory carried electric sterilizers—with current supplied by a gasoline-engine driven 110-volt generator—standard size refrigerators, and supply shelves located in the space ordinarily used for litters. Also pro-



Flying laboratory in operation.

vided in the plane were work tables and benches where 17 scientists could work at one time, effectively, but not in great comfort!

AIRPORT MAINTENANCE

*May be Improved by
Inspection from Helicopters*

HELICOPTERS are now suggested for use in servicing large airports. They could be used for such everyday work as daily inspection of runways and approaches, checks on possible damage to boundary lights conditions of painted numerals or guide lines and so on. It appears that the overall coverage of the helicopter is such that these tasks could be done much better from a helicopter than by automobile.

Conducted by The Staff

Powdered Coal

Vital Technical and Economic Significance Attaches to New Power Plant that Will First Challenge Diesel and Steam Power on the Rails. Of Prime Importance is the Promise of Saving Dwindling Oil Reserves. Further, it Will Eliminate Water Supply and Boiler Problems

FOR 50 years some of the world's leading inventors have been dreaming of feeding an internal combustion engine with cheap and abundant coal instead of gasoline or oil. Rudolph Diesel planned to run his now famous engine on powdered coal. He couldn't make it work and a number of later attempts, aimed at the same end, were abandoned. The coal was hard to feed and the gritty ash damaged the engines. Still it remained a shining hope for ambitious engineers, who foresaw an industrial revolution if they could wrest power directly from inexpensive coal instead of burning it less efficiently beneath a boiler to make steam.

Now it has been done. In the basement of a laboratory at Johns Hopkins University in Baltimore the world's first successful powdered-coal turbine has been whirling away since last December. Cheap bituminous coal goes in at one end. It is reduced to the fineness of confectioner's sugar by an ingenious but simple mechanism and shot directly into a roaring combustion chamber. Purged of the abrasive ash particles by a man-made whirlwind, the super-hot gases of combustion spin the blades of a turbine.

This pioneer machine is a sprawling affair. It was not built for beauty, but to prove a principle. That principle has now been proved, and work has already begun on a compact, streamlined successor to be mounted in a locomotive. Half a

dozen of the country's leading railroads and three major coal companies are gambling on its future, and it now appears that the coal-burning gas turbine will soon be challenging Diesel and steam power not only on the rails but in ships and stationary power-plants as well.

The ultimate importance of an engine that will take coal and make it perform like oil can hardly be over-estimated. It is an accepted fact that our oil reserves are vanishing; the price of oil seems certain to rise over the years as wells go deeper and oil searching goes farther afield. Eventual exhaustion of our oil reserves is inevitable. But we have plenty of coal—enough to last 3000 years at least. Gasoline and Diesel oil can be made from it by costly chemical processes, but it is obviously cheaper to burn the coal directly.

STEAM ENGINES INEFFICIENT —

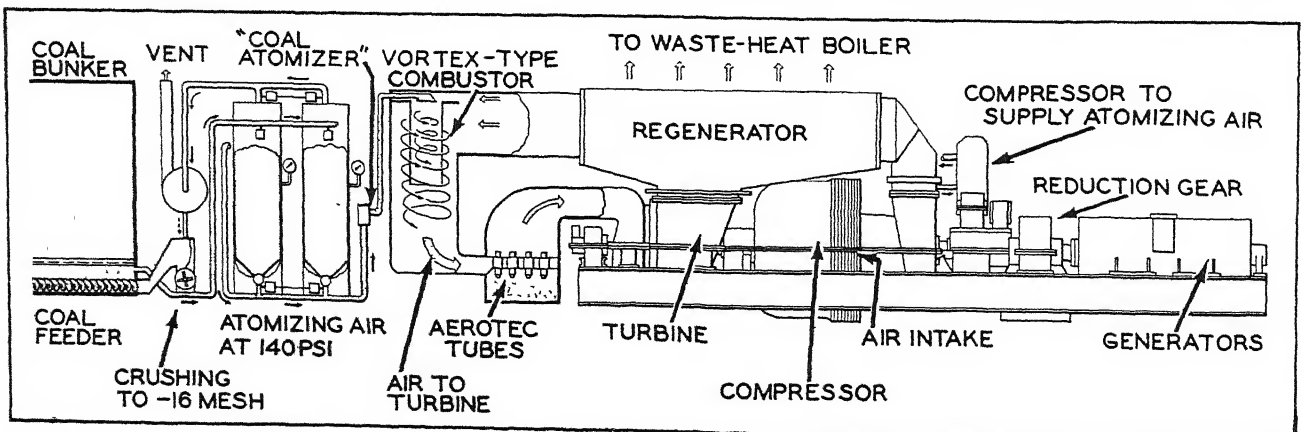
Only 18 months ago, the coal-burning gas turbine—or something like it—was a mere gleam in the eyes of a group of railroad and coal company executives, spark-plugged by Roy B. White, president of the Baltimore and Ohio. The group met to consider a common problem: Railroads get an important slice of their income from carrying coal, so it is to

their interest to promote its use. But most coal-burning steam locomotives are inefficient in many respects. They convert less than 8 percent of the coal's heat units into power; they waste time taking on water; they jerk passengers when they start; they pound the roadbeds, and they spray the countryside with smoke and cinders. The highly efficient, smooth-starting, oil-burning Diesel has for several years been pushing the old iron horse out of the picture.

"What this country needs," said Mr. White, "is a better coal-burning locomotive, but it will take plenty of money and one of the best men in the country to build it." So they passed the hat.

The presidents of the Baltimore and Ohio, the Chesapeake and Ohio, the Louisville and Nashville, the New York Central, the Pennsylvania, the Norfolk and Western railroads and of the M. A. Hanna, Island Creek, and Sinclair coal mining companies, joined with Bituminous Coal Research, Inc., to raise a million dollars and to form the Locomotive Development Committee. Mr. White was selected as chairman and he set out to find the man to do the job.

The man was found in John I. Yellott, brilliant Johns Hopkins



How the coal-burning gas turbine will be set up for locomotive service

Feeds A Turbine

By HARLAND MANCHESTER

• LOOKING AHEAD •

Applications of the efficient gas turbine will be vastly broadened. . . Rail use initially. . . Then in ships and stationary power plants. . . Even home-heating problems may bow to new powdered coal technology. . . Diesels may yet operate on solid fuel.

graduate who at 32 became head of the department of mechanical engineering at Illinois Institute of Technology, and who in 1939 was be-medaled by the American Society of Mechanical Engineers as the outstanding young man in his field. Later he became chief of the noted Institute of Gas Technology in Chicago. There he plunged into experiments with gas turbines, and also directed the war training of 55,000 technicians in the fields of explosives, ordnance, aircraft engines, and radar.

MAN WITH IDEAS — Yellott jumped at the exciting new commission, and left for Baltimore about a year ago to begin work. He knew about where he was headed, for he had already designed one of the most important parts for such an engine and applied for patents. He was prepared to spend five years translating his ideas into metal and fire, but he had his turbine running before Christmas.

Yellott's coal-burning gas turbine is a close relative of the jet-propulsion plane which has been shattering speed records for the last three years, and of the turbo-supercharger which enables bomber engines to breathe at high altitudes by using the power of the exhaust gases to pack more air into their carburetors.

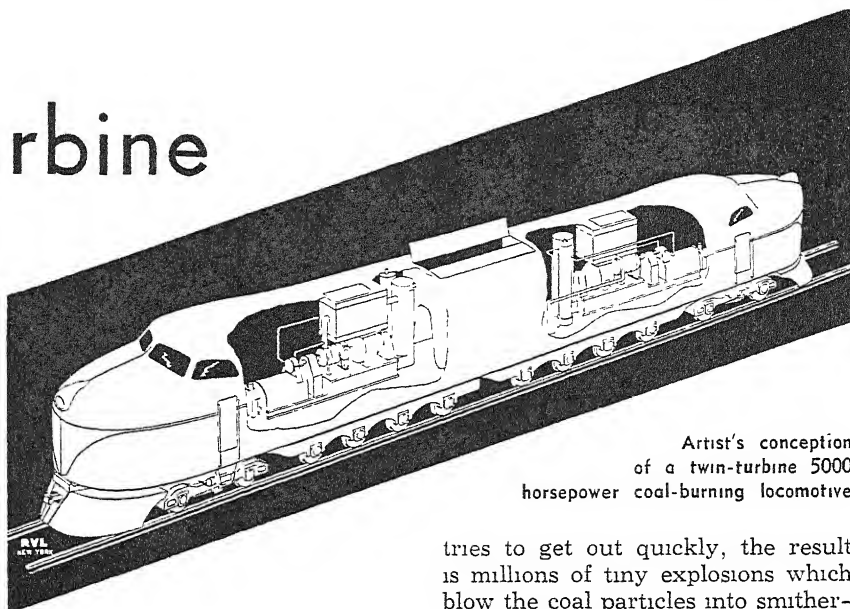
In the jet plane, a fanlike compressor forces air through a combustion chamber where fuel is burned. The flaming hurricane turns a turbine—a super windmill—which runs the compressor, and with its

remaining power streaks out through the jet and drives the plane forward. In the gas turbine—as contrasted with the jet—all the hurricane's strength is expended upon the turbine, which, after running the compressor, delivers a husky dividend of useful power for driving generators or turning wheels. The hot gases which do the work don't care what fuel heats them, as long as it has enough energy in it.

Various grades of gasoline and kerosine have been used as fuel for the gas turbine, but many engineers have been lured by the goal of cheap coal. Experiments to this end are being quietly conducted both here and abroad. But Yellott is the first to solve enough of the problems to produce a turbine that really works and can be put into production.

At Johns Hopkins, where the new engine stands in a rectangular space about the size of a locomotive, Yellott traced its operation for me all the way from the coal bunker to the spinning turbine. It is not so much an invention, he says, as a putting together of devices already invented to create something new.

"ATOMIZED" COAL—Soft coal in the bunker is slowly fed into a preliminary crusher which reduces it to the size of percolator coffee. This is still too coarse for the turbine, so it is "atomized" in a cylindrical device invented by Mr. Yellott while he was still teaching in Chicago. This atomizer works something like the machine used by cereal manufacturers to make "food shot from guns." The "percolator-size" coal is blown at high pressure through a nozzle, where the air pressure is suddenly released. The air trapped in the pores of the coal



Artist's conception of a twin-turbine 5000 horsepower coal-burning locomotive

tries to get out quickly, the result is millions of tiny explosions which blow the coal particles into smithereens of microscopic size.

"Atomized" coal is a soft, fluffy powder which feels like lamp-black or instant coffee when you rub it between your fingers. It is now so fine that it will burn like fuel oil, when blown into the combustion chamber, creating the raging inferno which a gas turbine demands. This powdering of the coal, by the way, uses up only about 2 percent of the power produced.

Ever since the first inventor thought of feeding fine coal to an engine in place of oil, the big question has been: How do you get rid of the ashes? If the "fly-ash"—the tiny cinders which remain when powdered coal is burned—were allowed to pelt the whirling turbine blades, the resulting abrasion would cut through them the way a sand-blasting machine cuts stone or brick. In the many attempts to run a Diesel on powdered coal, the ash has always scored the cylinders; even the hardest metals were unable to resist the harsh particles.

ASH PRECIPITATED—Yellott solved the fly-ash problem by removing the dust particles before they hit the blades. The Aerotec dust precipitator, a war-time invention used in tanks, trucks, and airplanes, does the job. During the early fighting in Libya, engines wore out rapidly because fine particles of sand were pulled into them through the air intakes. The problem was turned over to the Pratt-Daniel Corporation of Connecticut, which for years had been making cinder-catchers for factory smokestacks. From this device, the Aerotec Company, a firm created for the job, developed a small centrifugal dust precipitator which was an immediate success, cleaning air as no filter could.

In these precipitators, dust-laden

air is whirled around inside a tube at high speeds. Centrifugal force throws the solid particles out to the wall of the tube, where they fall downward and are trapped for future removal.

Yellott installed a battery of these precipitators between the combustion chamber and the turbine and the problem that had baffled inventors for half a century was licked. The precipitators take out 95 percent of the fly-ash, and the remaining dust, says Yellott, you could put in your eye without noticing it. The air which his locomotive will exhaust, he states, may actually be cleaner than the air it takes in. And if experiments now under way in another laboratory at Purdue University are successful, the ash salvaged by the precipitators will be used for sanding the rails, supplanting the two tons or so of sand now carried by locomotives.

The advantages offered by the new coal-burning turbine sound like a railroad man's dream. Calculations indicate that Yellott's blue-print locomotive, soon to be built, will be three or four times as efficient as today's coal-burning steam locomotive. It will use no water—a great advantage everywhere and especially in arid sections. With no boilers to inspect and clean and few moving parts, it will be far cheaper to maintain. It is so compact that a locomotive half the length of a Diesel-electric will deliver an equal amount of power. It will use any kind of coal, even the cheap

Thermal Efficiencies of Locomotive Power Plants		Average Fuel Costs per Million Btu (December 1945)	
Diesel	36 percent	Diesel Oil	39.0 cents
Gas Turbine	24 percent	Fuel Oil	17.3 cents
Reiprocating		Coal	13.1 cents
Steam Engine	8 percent		

Turbine efficiency is only two thirds that of a Diesel; now low cost powdered coal, burned directly in a turbine unit, more than offsets lower efficiency

lignite variety found in abundance in Texas, Montana, North Dakota, and parts of Canada.

LOW FUEL COST—Coal to run it will cost about one half as much per ton mile as fuel for a Diesel, and will probably cost relatively less in the future. It is certain that Diesel oil will never be any cheaper, and Yellott has plans that may make the powdered-coal gas turbine even more economical. For example, he hopes to eliminate the electric drive which will serve as a gearshift in the first coal burning "turbomotive" as it does in the Diesels now on the rails. Gearing the turbine directly to the wheels by means of an automobile-type gearshift would cut the fuel bill still more as well as reduce initial and maintenance costs.

Oil-burning gas turbine locomotives will be only two thirds as efficient as Diesels. The Diesel is still the most efficient internal-combustion engine in the world, delivering as high as 36 percent of the power potential of its fuel as against the gas turbine's 24 percent, the central station steam turbine's 30 per-

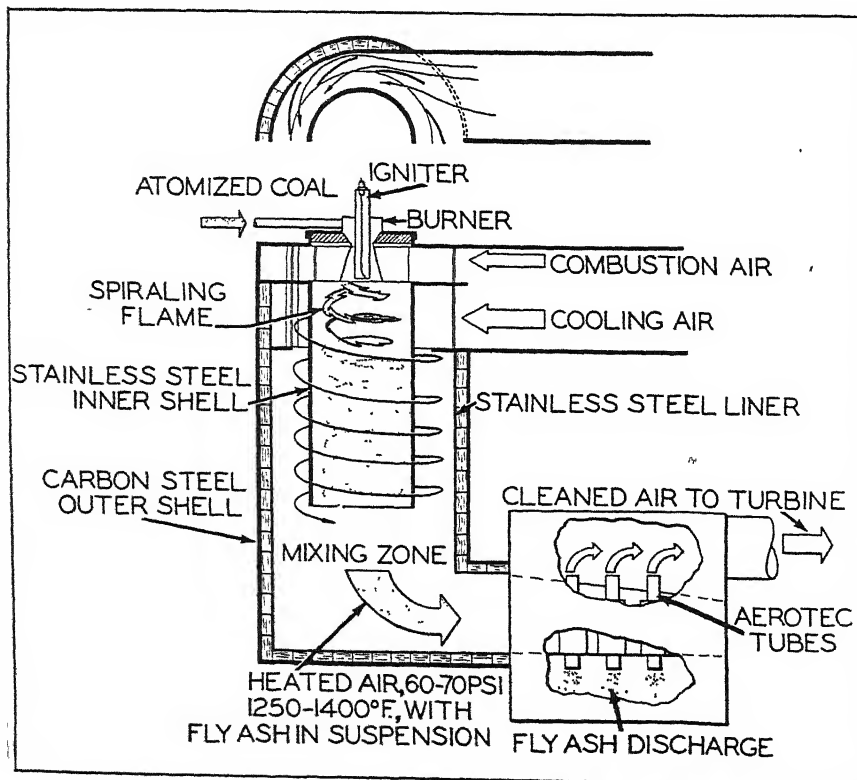
cent, and the steam locomotive's 8 percent. But the gas turbine can now burn coal which costs only one-third as much per heat unit as Diesel fuel, thus more than canceling out the Diesel's efficiency advantage.

The turbine locomotive will not pound the rails because it has no reciprocating piston action. Still another virtue of the turbine which appeals to railroad men has been noted by jet-plane pilots in cold northern climates. When a gas turbine draws in cold air, its power goes up by as much as 50 percent. This is because cold air is denser, and much more of it can be driven through the compressor with the expenditure of less power. This fits neatly with the fact that it takes more power to pull a train in winter, when grease congeals and the wheels of a standing train often freeze to the rails. The exhaust from the turbine can also supply the comfort-heat requirements of the train.

Many other possibilities lie ahead. Convertible gas turbine locomotives which will burn either coal or oil are being considered. Thus a train leaving the oil-rich West Coast could switch to coal east of the Rockies. The coal-burning gas turbine should be ideal for stationary power plants in regions which have plenty of coal and a limited water supply. Suitable for loads all the way from 500 to 10,000 horsepower, it may once more make coal supreme on the seven seas. Oil-burning gas turbines are now being built for ships, and a shift to coal would be a big money-saver. Yellott has his eyes on harbor tugboats, which he thinks may well be marine pioneers in the new power.

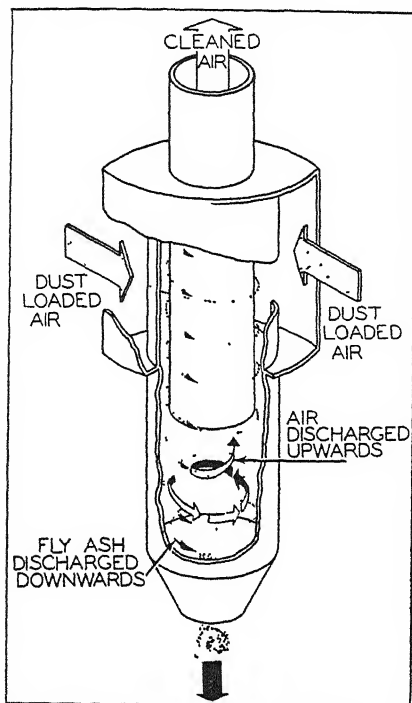
Bituminous Coal Research, Inc., which sponsors the present work, through its Locomotive Development Committee, is taking out patents only to keep the development from being bottled up, and will license all firms which want to build the new engine. The Committee's major interest is in promoting the use of coal.

OTHER USES—Important offshoots are being explored. As a long-range project, Yellott plans to bring to fruition Diesel's old scheme of feeding his internal-combustion re-



Details of the coal-burning turbine's combustor and fly ash eliminator

ciprocating engine on coal. He has in mind an attachment for the engine to pulverize the coal, turn it into gas, and inject the gas into the cylinders. Meanwhile work is progressing on a home furnace to be fed automatically with an air-driven stream of powdered coal. The "face-powder" fuel would be delivered in dust-tight containers. Combustion



Principle of operation of the Aero-tec tube as applied to removal of fly ash from hot air that operates the new coal-burning turbine rotor

would be practically complete and smokeless, the remaining cinders would be removed by adapted Aero-tec tubes, and houses would have exhaust pipes instead of chimneys.

Next to atomic energy possibilities yet unrealized, the gas turbine ranks as the most important power development of the 20th Century. The new engine in Baltimore, designed to conserve vanishing oil and to use abundant coal, promises to complete the power revolution which the gas turbine has started.

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ACCIDENT COSTS

*Magnified Four Times
by Indirect Losses*

THE HIGH indirect cost of industrial accidents—four times as great as the direct cost—should be regarded by management as an important factor when determining cost-control policies, George K. McKenzie, vice president and secretary of the Flint-kote Company, told the safety divi-

sion of The American Society of Mechanical Engineers at a recent meeting.

Authorities agree that the indirect cost of industrial accidents involving injuries to persons is four times greater on the average than the direct cost of the medical payments and the disability benefits. Some examples of indirect costs are: cost of time lost by other employees who stop work out of curiosity, out of sympathy, or to assist the injured employee; cost due to the damage to the machine, tools, or to the spoilage of material; incidental costs due to interference with production, failure to fill orders on time, payments of forfeits, and similar causes.

In other cases, loss of profit on the injured worker's productivity and on idle machines is a substantial cost factor, while supervisory time losses in selecting and training a new worker, preparing accident reports and investigating the cause of the accident are almost always present.

GAP-FILLING GLUE

*Holds Well in Imperfectly
Fitted Wood Joints*

A MODIFIED and improved version of the resin adhesive known as Beetle cement, which was used by the British in aircraft construction during the war, is now being manufactured by the American Cyanamid Company under the name Urac 185. The essential difference between this and other resin glues is the fact that it can be used successfully for glue lines up to .020 inch in thickness without danger of cracking or crazing and ultimate structural failure. Because of these non-crazing properties, it is not necessary for the joints or surfaces to be perfectly machined. It is said that they can be glued just as the wood comes from the saw. The urea-formaldehyde resin provides a water-resistant



glue line and is also resistant to attack by fungus.

An example of the applications to which the glue is suited—in addition to many industrial uses—is found in the repair of small boats. Here, such structural repairs as the replacement of broken ribs, often a difficult job requiring steaming equipment, may be simplified by the use of Urac 185 and glued laminations which do not require heat or pressure to set. The gap-filling and craze resistant properties are helpful in avoiding the problems involved in matching imperfect surface contours.

DDT FORMULAS

*Matched to Uses, Aided
by New Vehicle, Bug "Flusher"*

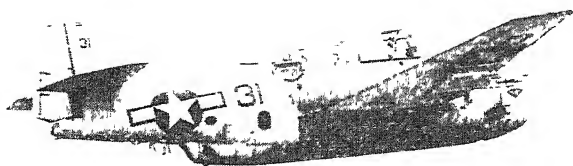
ANNOUNCEMENT of a colorless synthetic resin liquid which promises to make use of DDT safer, faster, more permanent, and practically fool-proof is coupled with the statement that no one DDT formula can solve all insecticide needs. The manufacturer, the Sherwin-Williams Company, feels that much confusion stems from various attempts to make an all-purpose DDT. Hence the development of a DDT powder to accompany the resin-liquid—and still another formula for farms and business places.

Since DDT consists of microscopic crystals, which the insect's

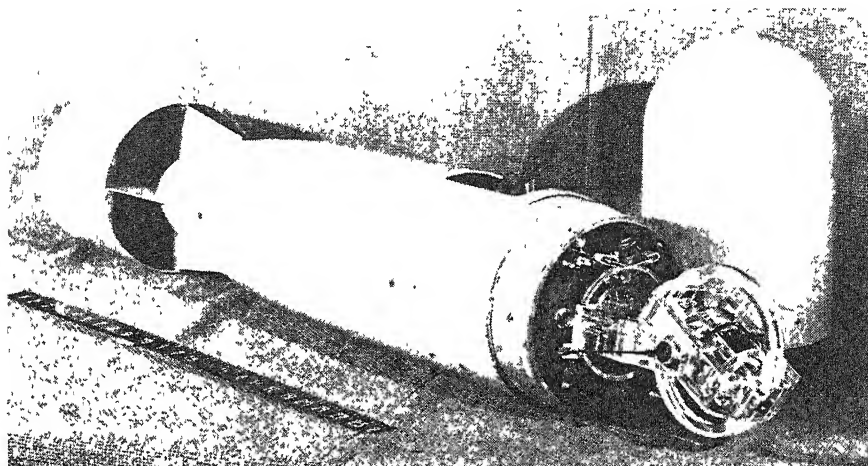


Repairing a boat by use of gap-filling glue and laminated ribs. Left: The glue is applied to the surface of the first ply, which was cold-bent to shape and screwed in place. Above: The second ply is bent and fastened

foot need only touch lightly to cause death in a matter of minutes, it was necessary to find a resin-coating which would hold the crystals on the surface, and permit lower layers of crystals to "migrate" to the surface at a controlled rate for months to keep the DDT



Left: How the aerial "doodle bug" is trailed from an airplane. Below The airborne magnetometer with nose cap removed, compared with two-foot scale



coating lethal. Brushed onto screens, porch ceilings, floors, light fixtures, stairs, and so on, the new resin-coating, called "Pestroy," quickly dries, leaving an almost invisible, non-shiny film. Flies, mosquitoes, fleas, ants, moths, roaches, and bed-bugs are said to be almost instantly paralyzed as the "lipoids" of their feet touch the exposed crystals. Complete safety, however, is claimed for humans, particularly children, who may touch the coated surface, since the crystals do not rub off easily. Inside, the coating is said to remain effective at least three months; outside, at least a month.

Companion to the resin-coating is a powder containing 10 percent DDT and a chemical "bug-flusher" known as pipernylcyclohexanone, which makes it more effective. The chemical causes bugs to leave their cracks and thus come into contact with the deadly powder.

Pestroy powder is marketed in an applicator-top container which squirts a stream of powder into cracks and hard-to-reach places where roaches, moths, and bed-bugs lurk. Dogs may also be dusted to kill fleas and lice.

TIN FOR CARS

Replaced by Newer Materials, Better Techniques

DUE TO a continued scarcity, at least 50 percent less tin is being used in 1946 passenger cars than in pre-war models. In 1942, the average automobile contained 3.72 pounds of tin, mostly used in solder, or to prevent corrosion, or as a finishing material for moving parts such as pistons. Today, the average amount of tin going into cars is 1.73 pounds.

Alternate materials and manufacturing methods developed to meet heavy-duty, military vehicle needs now help to accomplish the tin saving without any diminishing of automobile quality. Examples of such

changes include a new "tinless" body solder, and chemical and brass coatings to replace the formerly used tin "lubrication" surfacing for aluminum pistons.

AERIAL DOODLE BUG

Speeds Surveys of Earth's Geophysical Structures

PROSPECTING by air for potential oil and mineral producing areas is possible with a new device developed as an outgrowth of a hitherto secret means of magnetically finding and tracking submerged enemy submarines. Termed the magnetic airborne detector, and familiarly known as "the aerial doodle bug," the device provides a means for a quick, large scale survey of those geological structures which may include valuable natural resources. It is expected to be especially valuable in such now inaccessible areas as polar regions, jungles, and offshore tidewaters.

The device was developed by Bell Telephone Laboratories in co-operation with the Naval Ordnance Laboratory under the auspices of the Navy's Bureau of Ordnance and Bureau of Aeronautics. Another magnetometer was developed by Gulf Research and Development Company, working independently and later under contract with the National Defense Research Committee.

Engineers associated with the development emphasized the reconnaissance nature of the device and pointed out that its chief value lay in its capacity to outline rapidly those areas which are promising, and

which should be more intensively investigated by ground parties. In this connection, it was noted that the aerial doodle bug does not actually detect oil deposits but, by mapping geological structures, indicates those peculiar areas in which oil is usually found.

The principal feature of the new

system is an airborne magnetometer—measurer of magnetism—which for peace-time use, has been revised somewhat and combined with Shoran, a radar-mapping device, and with special mapping cameras. Thus, in addition to being a speedy preliminary survey tool, the new device also gives a more accurate appraisal of the geological structure of an area than that obtained by ground parties using conventional methods of magnetic exploration. Further, the airborne detector draws a continuous magnetic record of the terrain over which it is flown and in so doing disregards small and relatively unimportant magnetic irregularities.

The new instrument may also be used by oceanographers and geologists in the study of offshore geological conditions.

MORE ABOUT SILICONES

High Temperature Lubricants and Heat Resisting Paints

BALL BEARINGS permanently lubricated, paints that will protect hot engine mufflers and furnace fronts, motor oils and lubricating greases that will not fail under continued high temperatures, are all possible through the use of silicones, according to W. R. Collings, vice president and general manager of Dow Corning Corporation. These new products have properties which "will simplify the problems of the chemical engineer," said Mr. Collings, who spoke on silicones as new engineering materials at a recent meeting of the American Institute of Chemical Engineers. He revealed

that one of the simplest silicones, Hexamethyldisiloxane, was valuable as a compass fluid during the war because its viscosity changes only slightly with variations in temperature.

Regarding motor oils, he said that "for general high temperature lubricating purposes it was necessary to develop a fluid of a different type than the straight chain silicones." He also revealed that a silicone fluid is now in production that is equal to ordinary motor oil in lubricity at normal temperatures, is non volatile, and it has no tendency to gum at operating temperatures as high as 400 degrees, Fahrenheit

Mr. Collings also pointed out that new silicone greases would be ideal for permanent lubrication of ball bearings since they exhibit the lowest volatility and the greatest heat and oxidation resistance of any known greases. Tests conducted in ball bearings indicate that the silicone greases now available will operate successfully at temperatures of 300 to 320 degrees.

Resins made from silicones have excellent protective properties. Mr. Collings stated that pigmented varnishes using aluminum powder have been used successfully for protective coatings on furnace fronts, stacks, Diesel engine mufflers, and on many other steel surfaces at temperatures up to 600 degrees, Fahrenheit Heat resistant mineral pigments can be used also but they will not withstand as high temperatures as aluminum. The greatest volume of so-called silicone paints has been used in the middle west on hot equipment around oil refineries

TURBINE SIZES

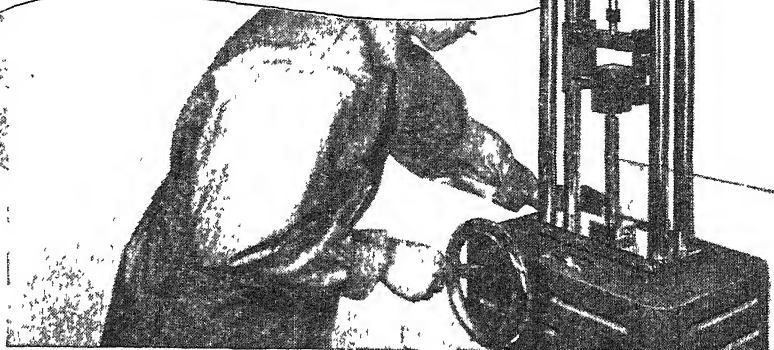
*Fixed by New Standards
as Production and Service Aid*

THE FIRST "standardized" steam turbine built for electric power generation is now in production. The unit is the result of a long-felt need to remove the "custom-made" label from such machines and introduce certain standard sizes and operating conditions.

According to Westinghouse Electric Corporation, steam turbines, the source of much of the nation's mass-production power, have always been tailor-made. Thus, this recent development, brought about by a committee organized by the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, can be described as a definite step toward improving the power facilities of the country and at the same time giving more satisfactory service to the public in general.

Ingenious New Technical Methods

To Help You with Your
Reconversion Problems



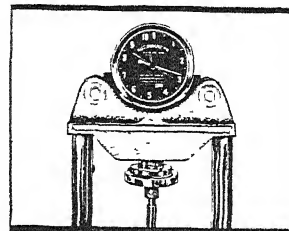
Portable Tester Checks Tensions Up To 10,000 lbs.—Right at the Workbench!

Standing only 37" high, weighing but 137 lbs., the Dillon Universal Tester checks wire, copper, aluminum, fabrics, steel, etc. for tensile, transverse, compression and shear strengths. Available in 7 capacities, with interchangeable dynamometers, the Universal will test from 0 to 10,000 lbs. Special gripping jaws are made for every requirement.

The Universal Tester may be either hand or motor operated. No special training is needed to record accurate results instantly on the dynamometer. It is compact, simple, inexpensive—designed for small shops and plants everywhere.

Tests prove that workers, too, undergo strain and nervous tension on the job. That's why many factories urge workers to chew gum. Workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy. And the act of chewing helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety.

You can get complete information from
W. C. Dillon & Company, Inc.
5410 W. Harrison St., Chicago 44, Illinois



Interchangeable Dynamometer



AA-78

The six sizes of turbines, decided upon by the committee as within the range of the most common of the larger power-plant sizes and therefore the most suitable for standardization, run from 11,500 to 60,000 kilowatts in productive capacity. This is sufficient range to provide power for cities from 10,000 to 50,000 population. With a plant's productive facilities geared to a definite number of turbine sizes, many types of stock parts—such as blades—can be turned out in quantity for use in future orders or to be kept in reserve as replacements.

It is expected that eventually this standardization will have a two-fold

result. First, it will speed up production and facilitate quicker delivery of equipment, and secondly it will be much easier to provide repairs and to service machinery than before. The standardization program will not hinder production of any size of steam turbine-generator needed for purposes for which the standard specifications might not be suited. Neither will it prevent building duplicates of machines already installed and for which designs and patterns are available. Further benefits are anticipated in that the amount of effort formerly devoted to custom designing may now be turned to research.

New Products and Processes

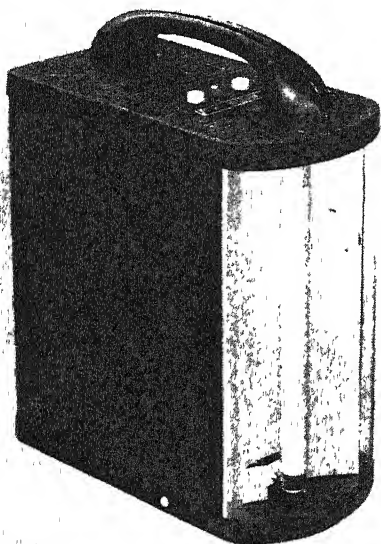
PORTABLE LIGHT

*Is Fluorescent Type,
Operates on Battery*

INTENDED for use wherever a portable, self-powered light is needed, a new flood-light incorporates a six-watt fluorescent tube and uses a standard B-battery as the power supply. With continuous use, the battery will provide light for about 30 hours.

Known as the "Totelite," the unit is contained in a single 24-gage steel case finished in crackle-type enamel. Its lens shield, described as non-breakable, is transparent Lumarith. The plastics carrying handle is located just above the convenient one-hand control.

Dimensions of the light are 11 by 8¼ by 4½ inches, and the weight is seven pounds with battery installed. The makers, Paramount Industries, Inc., call attention to the fact that the light



Light is completely self-contained

is not a spot-type but has a full 180-degree light spread.

Suggested applications for the portable unit range from industrial and domestic emergency illumination to routine uses by electrical, plumbing, and maintenance employees. Motorists, sportsmen, and farmers are also expected to find the light convenient and practical.

AUTO LACQUER

*Offers New Effects
in Translucent Colors*

JUST introduced to the automobile industry is a new lacquer said to be the most durable ever developed, with colors and color effects never before

produced. Utilizing a new pigment technique and manufacturing process, "Duco" Metall-Chrome nitrocellulose lacquer, as the new finish is called, is produced in more than 200 grays, greens, and browns.

It is explained that the deep-glowing luster effect results from the high degree of translucency of the lacquer films. Light penetrates and is reflected back to the eye from within instead of from the outer surface of the film as it does when it strikes a conventional coating. The glowing effect is enhanced by small particles of aluminum flake which serve as tiny mirrors, diffusing and reflecting light from within the film.

Moreover, the translucent metallics afford a color variation as the lighting alters or the angle of vision shifts. Burnished gold and shades of bronze are also available.

The new finishes differ considerably from the so-called metallic finishes used before the war, and it is said that the majority of the colors are made possible by a new pigment material—ferric hydroxide. The reason the lacquers are translucent, it is explained, is because of the extremely fine particle size of the pigments employed. Du Pont chemists say the durability of Metall-Chrome is based on a different principle than the durability of conventional lacquers which are dependent to a large degree on the opacity of standard pigments which prevent destructive ultra-violet light rays from entering the film.

INDUSTRIAL RACK

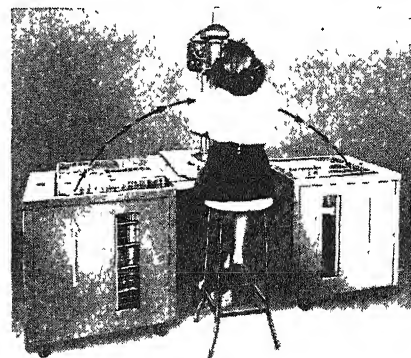
*Feeds Material to Hand
Level, Stores, and Transports*

A THREE-IN-ONE unit that combines automatic material handling with storage and transporting, features speedier production and elimination of psychological slow down, physical back strain, and accident factors involved in manual lifting of loaded tote boxes or in lifting materials to working levels. The automatic, spring-powered racks hold a visible bank of material and bring each piece to the operator's

hand level as soon as the preceding piece has been removed. Production benefits because the same working level is constantly maintained and flow of parts or material is continuously timed to the worker's capacity.

Reloading is accomplished by placing material on the platform where it automatically finds its proper level. Activated by self-contained springs, the rack requires no outside power source and is smooth and noiseless in action. Parts may be placed in tote boxes or the material may be placed directly on the platform.

Made by American Machine and



Constant material supply speeds work

Foundry Company, the units are designed to handle any weight. Load changes can be made by unhooking one end of the springs, accessible through a hinged door. The units, mounted on ball-bearing casters, can readily be moved from one department to another while the filled rack can be used as a storage unit.

FOIL LAMINANT

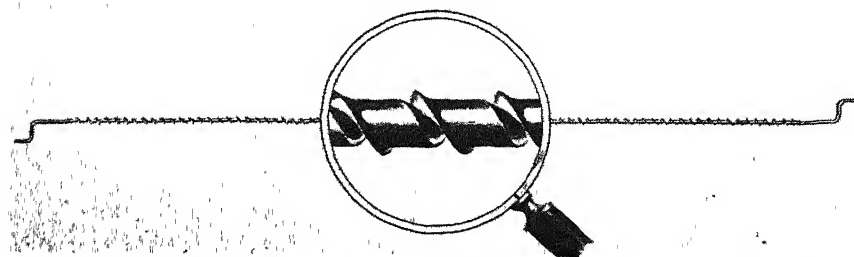
*Bonds Aluminum to Other
Materials with Synthetic Resin*

RECOMMENDED primarily for roll-applier machines, a new thermo-plastic resin emulsion adhesive is described as able to bond all grades of aluminum foil to cellophane, acetate, glassine, bond, kraft, sulfite, chip-board, and other materials. The manufacturer, Paisley Products, Inc., maintains a technical service department to assist users in adapting this product to their specific requirements.

"BARBER-POLE" TEETH

*Provide Jig-Saw Control
Without Turning Work*

SPIRAL teeth, running the full length of the blade body, are employed in new saw blades for hand coping saws or power-operated jig saws. On the



Enlarged view of saw teeth shows spiral that provides omni-directional cutting

Taylor "Allways" blade, the teeth cut in any direction without requiring the operator to turn the saw frame or the work to change the direction of cut. This stems from the fact that the blade is circular in section, hence its normal stock removal in one stationary stroke leaves a circle and a cut may be made in any line or arc from this circle without blade-binding or breakage.

It is said that nothing is lost in starting facility or cutting accuracy but that the new blade greatly simplifies intricate work such as scroll or fret cutting. Made of oil tempered spring steel and designed to cut all woods, light metals, and plastics, the blades are claimed to be unusually durable. Also, the peculiar spiral cut teeth make for safer use. Industrial applications—for carpenters, mechanics, repairmen, model makers, and cabinet and pattern makers—are anticipated.

SMOKE AND GAS DETECTORS

Possess Surprising Sensitivity,
Promise Wide Industrial Use

Two new instruments for detecting the presence of gas or smoke are said by the developers, Northwestern University, to be the most sensitive ever devised. One, the Northwestern Ultra-Violet Photometer, is a rugged, portable instrument for detecting the presence of gases by means of ultra-violet light. It can discover as little as one part of gas in a million parts of air.

With an automatic recording attachment it is expected to find considerable use in providing continuous measurement of toxic vapors in factories and mines. It may replace chemical analysis of gases in closed systems, it is explained, because it does not affect the substances analyzed.

Another instrument is so sensitive it can detect 1/100,000th of an ounce of smoke in a room 30 feet square, and is called the "Northwestern Photoelectric Smoke Penetrometer." The device gives instantaneous readings on the amount of dust in the air and a puff of cigarette smoke diffused in a huge auditorium will deflect its indicator. Its delicate electronic circuits must be hermetically sealed to insure accuracy.

The instrument can be used in studies of industrial plants, smoke elimination, and air purification and conditioning systems. It will also be employed in studying the concentration of various colloidal systems in the field of pure chemical research.

HIGH-DUTY BEARINGS

Resist Foreign Particles,
Use Aluminum Base Metal

ALUMINUM alloys containing tin, nickel, silicon, and copper were recommended at a recent meeting of the Society of Automotive Engineers as new materials for bearings which promise to accelerate progress in designing internal combustion engines.

Reports claim that the results of extensive experiments and tests re-

vealed these bearing materials to be superior for high-duty service in the engines both of land vehicles and aircraft. Other advantages appear to be abilities to resist wear, as well as damage by foreign particles, and to support much greater loads for prolonged operating periods.

ALUMINUM PANELS

With "Sandwich" Center
Now Made for Buildings

LIGHTWEIGHT, high-strength, economical aluminum building material which can be produced in large quantities has recently been announced. Known as "Reynalite," the product combines two

sheets of aluminum bonded with a plastics adhesive to a cellulosic core to form an attractive panel which possesses permanent rigidity, resists harmful elements, is easily worked, and is said to be adaptable to many major uses in building construction and related fields. It is described as impervious to moisture and to temperature changes.

Wood-veneer surface can be bonded to either of the metal surfaces, or both. In addition to building construction uses, the aluminum panels appear applicable to railroads cars, buses, trucks, and trailers. Adaptations are also reported in the furniture industry for use as table tops on occasional tables, coffee tables, and end tables. The heat-

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6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	63	1.10
6178-S*	45	189	1.50
6179-S*	48	78	1.25
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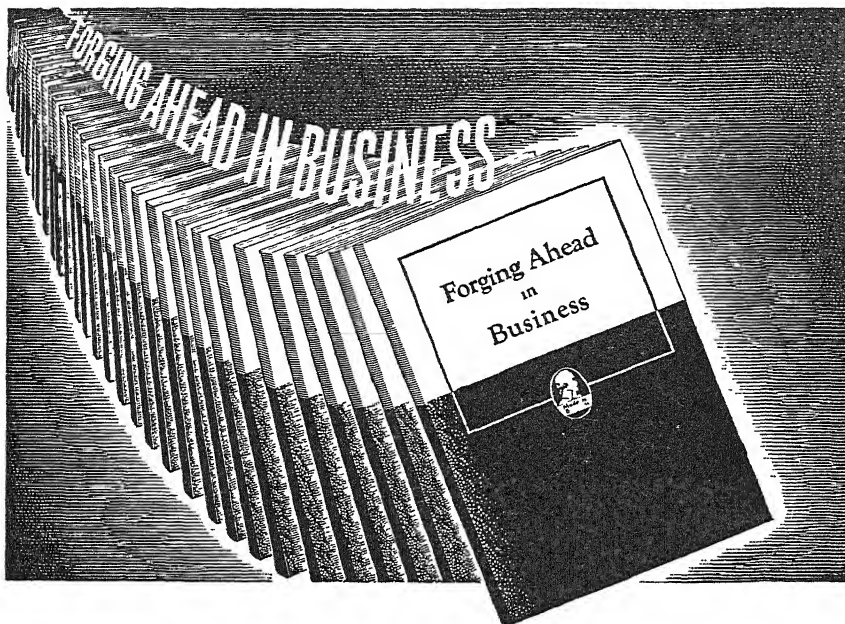
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Although "Forging Ahead in Business" has been distributed to more than 3,000,000 men, today's timely edition was written in the light of recent world-wide developments. Its 64 pages represent more than three decades of successful experience in training men for leadership in business and industry.

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The booklet further explains how it is possible to offer this essential training in a minimum of time; how the Institute program fits in with the most crowded of post-war schedules.

Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp., and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

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Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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conductive property of aluminum reduces to a minimum, and, in many cases eliminates—according to the Reynolds Metals Company—the danger of scorch or burn marks caused by matches or ashes falling onto a table top.

Further features are high insulating value, resistance to lightning and fire, and insect-proof properties.

For fabrication, the panels can be fastened with ordinary nails or screws and worked with common carpenter tools

CONTACT-FACE ALLOY

*Resists Pitting, Welding,
Under Heavy Currents*

DEVELOPMENT of a new silver-molybdenum alloy that is particularly suitable for facing of contact surfaces in switch gear designed to handle heavy currents has recently been announced. Called Callinite Type SM alloy, the metal is described as a high conductivity facing material suitable for applications where high currents may cause pitting, sticking, or welding of other contacts.

The alloy, produced by Callite Tungsten Corporation, is made in standard and special shapes.

SIGHT EFFICIENCY

*In Terms of Job, Checked
for Individual Employees*

AN AID in assisting employees to do a better job with greater comfort, the Ortho-Rater, a vision-performance tester, helps to assure selection and placement of individuals whose visual capacities fall within pre-determined requirements for each type of job. Developed in co-operation with Purdue University's Division of Education and Applied Psychology, the Bausch and Lomb instrument is now being used in many major industrial plants.

Testing is performed in a few minutes time, in most cases at or near employees' working station. Intended solely for the measurement of visual



Proper vision contributes to success

performance and not for refraction or diagnosis, the Ortho-Rater tests at far and near distances of 26 feet and 13 inches respectively.

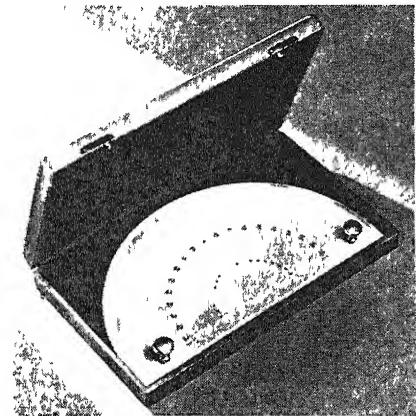
Studies are reported to prove conclusively that persons with high visual efficiency in their specific jobs, other factors being equal, are more likely to attain success.

Eye care is recommended to those whose vision is not right for the requirements of the job. It has been found that proper eye care will, in most cases, sufficiently improve eye skills to meet job requirements

PROTRACTOR

Precision Made on Plate Glass for Fine Layouts

WHERE requirements demand extremely accurate layouts for use on optical projectors and form grinders a new layout protractor made of 1/4 inch, beveled plate glass should prove valuable. The ruling is on the under side of the glass and, as a consequence the operator is assured accuracy of measurement since the ruled lines of the protractor are in actual contact



Rulings are on under side of glass

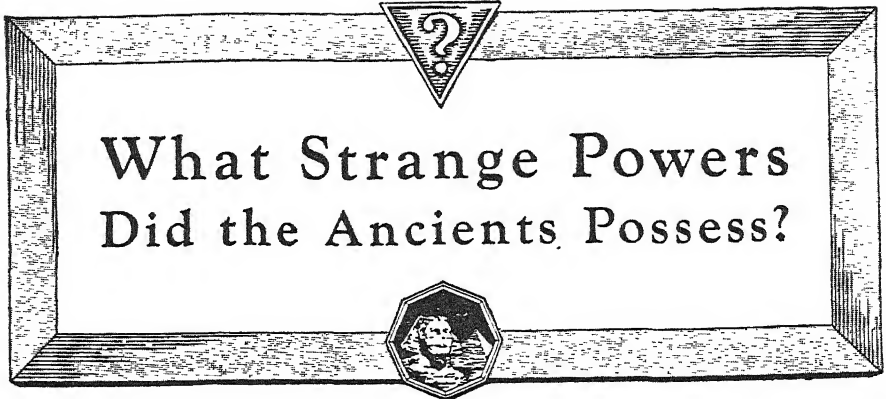
with the layout being produced or checked. The same feature is said to assure exactness of measurement on the screens of optical comparators

The circular edge of the glass is beveled to a thin outer edge through which the divisions are viewed. This contributes to the ease of accurately marking measurements with a very hard sharp pencil or scribe, or the reading of fine rulings so closely spaced that they designate intervals of but 10 minutes of arc. The layout protractor has cushioned metal handles, and is manufactured by the Engineers Specialties Division, The Universal Engraving and Colorplate Company, Inc.

HEARING AIDS

Powered by Flashlight Cells with Adapter Unit

STANDARD flashlight-type cells, in place of special socket-type cells, may be adapted to hearing aids by a new battery-holding device. Greater economy and added convenience, plus service equal to many of the more expensive socket-type cells, are advantages



EVERY important discovery relating to mind power, sound thinking and cause and effect, as applied to self-advancement, was known centuries ago, before the masses could read and write.

Much has been written about the wise men of old. A popular fallacy has it that their secrets of personal power and successful living were lost to the world. Knowledge of nature's laws, accumulated through the ages, is never lost. At times the great truths possessed by the sages were hidden from unscrupulous men in high places, but never destroyed.

Why Were Their Secrets Closely Guarded?

Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious silent something which "whispers" to you from within.

Fundamental Laws of Nature

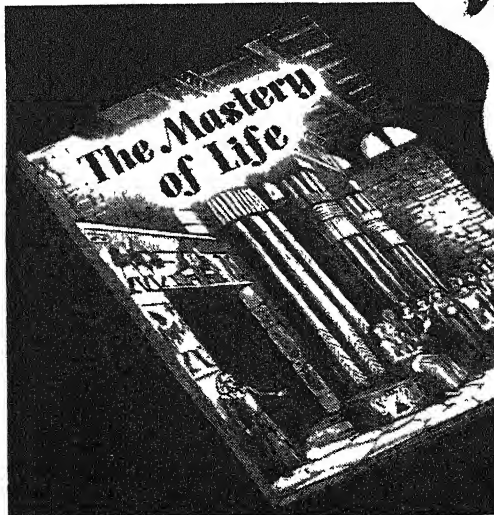
Your habits, accomplishments and weaknesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental

as the laws of breathing, eating and sleeping. All fixed laws of nature are as fascinating to study as they are vital to understand for success in life.

You can learn to find and follow every basic law of life. You can begin at any time to discover a whole new world of interesting truths. You can start at once to awaken your inner powers of self-understanding and self-advancement. You can learn from one of the world's oldest institutions, first known in America in 1694. Enjoying the high regard of hundreds of leaders, thinkers and teachers, the organization is known as the Rosicrucian Order. Its complete name is the "Ancient and Mystical Order Rosae Crucis," abbreviated by the initials "AMORC." The teachings of the Order are not sold, for it is not a commercial organization, nor is it a religious sect. It is a non-profit fraternity, a brotherhood in the true sense.

Not For General Distribution

Sincere men and women, in search of the truth—those who wish to fit in with the ways of the world—are invited to write for a complimentary copy of the booklet, "The Mastery of Life." It tells how to contact the librarian of the archives of AMORC for this rare knowledge. This booklet is not intended for general distribution; nor is it sent without request. It is therefore suggested that you write for your copy to the Scribe whose address is given in the coupon. The initial step is for you to take.



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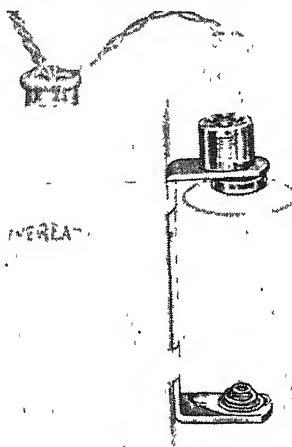
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claimed for the unit. In addition, standard cells are available almost anywhere at any time.

This offers greater convenience to traveling men, farmers, sportsmen, or others who are not always conveniently able to secure the socket-type hearing aid cells. The resultant savings in battery costs over a period of time is said to be considerable.

Called the Spitfire Battery Holder for "A" batteries, the retainer attaches to the "B" battery with a piece of adhesive tape and holds a flashlight cell firmly in place, making a compact unit



Economy, convenience are advantages

requiring no special carrying case. A socket on the holder contains two terminals, into which the plug of the hearing aid cord is inserted. Insulating plastics surround the contact terminals, providing positive assurance against short circuiting.

INSECT REPELLENT

Retains Power for Long
Periods, is Non-Toxic

COLORLESS, stainless, and relatively odorless a new insect repellent is reported to have repelled insects for as long as 36 hours in temperate climates and for as long as 10 hours under tropical conditions. The repellent, to be marketed under the name "d-Ter," is described as having been thoroughly tested with no incidents of toxic reactions to it.

Features of "d-Ter," made by Chandler Chemical Corporation, are that it will not harm any fabric, including nylon, or such things as nail polish and cosmetics. In diluted form, it is said that "d-Ter" can be sprayed on dogs to protect them from fleas and ticks, and on horses, sheep, cattle, and other live-stock, without ill effects. In this form it can also be used to keep flies, mosquitoes, midges, and gnats, away from screens and screen doors

PHOTOCOPY EXPOSURE

Quickly Determined with
"Simple-To-Operate" Slide

EVEN though photocopying units are quite easily handled by unskilled help, a new and simple exposure slide has

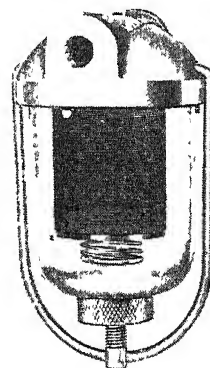
been developed to give instantaneous calculation of exposure time, thus bringing added speed to photocopying operations. The slide, which is now being distributed, is made of high quality varnished cardboard, measures approximately six inches long and three inches wide, and holds a movable chart whose figures appear through slots on the front face of the rule. Exposure time is given for five types of reproduction: positive, and reflex, reverse, alternate, and readable negative.

These exposures apply to documents ranging all the way from original tracings on very thin paper to newspapers, photographs and blueprints, and so on. Development of the slide is credited to American Photocopy Equipment Company.

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Filter, installed in sediment bowl (above), has multi-ribbon structure (below). Fuel passes between ribbons



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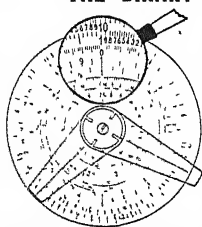
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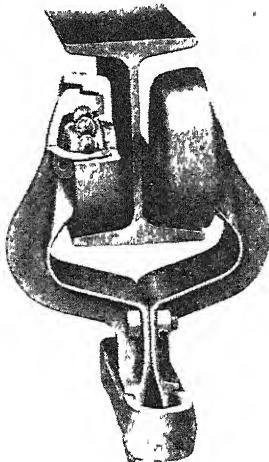
be cleaned off by blowing compressed
air, or the breath, into the cylinder.
The cylindrical element is known as the
Kwick Klean Kartridge

Called the Skinner Purifier, the unit
is claimed to separate free water from
gasoline as the result of a laminated
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separate retainers for its full comple-
ment of hardened alloy-steel balls. Two



Even wear-distribution and greater
bearing-area increase conveyor life

basic elements—wheel and one-piece
bracket—themselves form the deep in-
ner and outer races of the bearing. The
inner-bearing race, being a part of
the wheel forging, revolves within the
outer race formed by the head of the
trolley bracket.

The revolving inner race is said to
distribute wear completely around the
ball-path. All fixed points of pressure
are on the outer race, where the larger
diameter provides a greater area of
distribution and, consequently, greater
resistance to wear. The bearings are
assembled by holding the wheel in po-
sition on the head of the bracket and
then dropping the balls into race-
groove through a ball-loading hole at
the back of the bracket.

Protective felt seals and lubrication
reservoirs are features of the design.
Wheels and brackets are drop-forged
steel, with ball races accurately ma-
chined and hardened. Another feature
is the inclusion of both the outer-bear-
ing race and the carrying attachment
in a single bracket, resulting in fewer
parts and a more pleasing appearance.
The lower ends of the two brackets are
connected by two bolts, and have hori-
zontal flanges between which the

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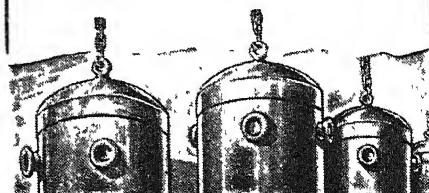
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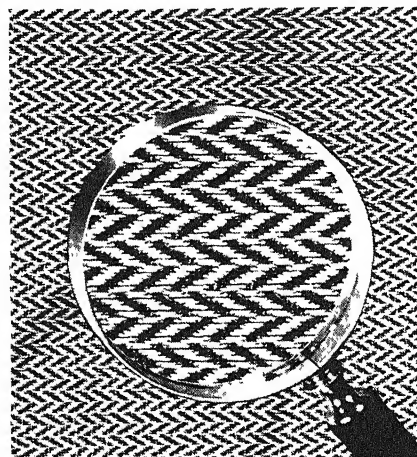
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It is reported that Saran fabrics are being specified for shipboard, automobile, and plane upholstery in addition to uses in shoes, and luggage. The materials feature "built in" color and the monofilaments are extruded in both transparent and opaque types. The pigments and dyes may be added to the molding powder before extrusion.

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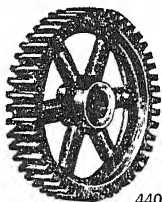
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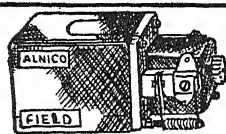
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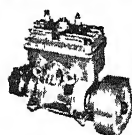
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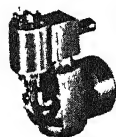


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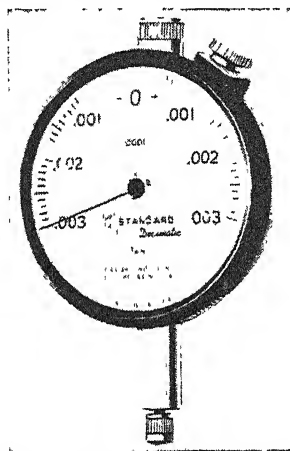
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Numerals match blueprint tolerances

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Had Broad Application
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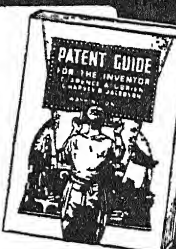
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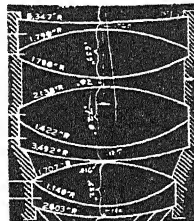
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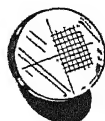
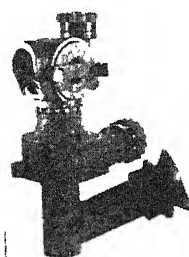
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DALL of England was the first to make the special type of Cassegrainian telescope having a spherical secondary mirror instead of the usual hyperboloid, with the primary figured to fit it. He made several, the first in 1931. But he did not stop to publish the design details. Independently, the late Alan R. Kirkham in 1938 published the design data in these columns. George P. Arnold, 519 Holmes St., State College, Pa., now contributes the following article on the testing and performance of this type.

THOSE desiring to study the Moon and planets from a comfortable and safe position would do well to consider the Cassegrainian. Properly constructed, it is the equal of any ordinary refractor of the same aperture, and is practically as good as the equivalent Newtonian. Despite its desirable features, many may have hesitated to make Cassegrainians after reading the warnings by various authorities on the difficulties involved, which are probably real enough with the conventional type. By modifying the design, however, construction is greatly simplified and testing becomes much easier.

The biggest step toward simplifying the Cassegrainian was made by Dall and Kirkham, who made practical the substitution of a spherical secondary for the customary hyperboloid, thus eliminating the need for another large

and secondary foci, respectively. All quantities in the above and following equations are to be considered positive.

The primary is thus figured to an amount $N r^2/R$ instead of the usual r^2/R . With mirrors of short f -ratio, testing in the usual way is still rather difficult, as small zonal irregularities may easily be overlooked and the knife-edge must be set and read with considerable accuracy. Kirkham suggested that the undercorrected primary could be considered to be an ellipse, in which case the source is at one focus, and the mirror, with the knife-edge at the other focus, should present the appearance of a sphere at the center of curvature. Dall mentioned (Sci. Am., May 1939) that he tested his 15" primary with the knife-edge at the remote focus some 120' from the mirror. Neither, however, gave a formula for finding the position of the foci. Referring to Figure 1, f and f' are the foci of the ellipse, and it can be shown that the distances a and c are very nearly

$$a = R/(1 - N), \quad c = a\sqrt{N} \quad (2)$$

where R is the radius of curvature of the primary, N the fractional correction given by Kirkham's formula.

In practice, the source may be placed either at f , at a distance of $a + c$ from the mirror, or at f' , distant $a - c$ from it; the image will be found at the other focus. As an example, consider a 10" $f/5$ primary, to be 73 percent corrected:

$$\begin{aligned} R &= 100", \\ a &= 100/(1 - .73) = 370", \\ c &= 370\sqrt{.73} = 316". \end{aligned}$$

Then f is $370 + 316 = 686"$ from the mirror, and f' is $370 - 316 = 54"$ from the mirror, which will appear flat under the knife-edge only if it is corrected to $0.73 r^2/R$. Actually, however, f can be moved several feet in either direction before a lack of flatness is perceptible, as this corresponds to only a very slight change in N . If the source is at f , a small flat must be used to place the image where it can be knife-edged; this complicates collimation, but adjustment can be made by one person, as the mirror is only a few feet away. Any lack of collimation is easily detected by the appearance of the knife-edge inside focus or, better, by the distortion of the Ronchi bands. The mirror appears much larger at the near focus, and the effect of a very narrow source is obtained. It is not too difficult to make a slit finer (at the distance it is placed) than the resolving power of the mirror; when this has been done, a Ronchi wire one or two thousandths of an inch in diameter may be conveniently used, and the test becomes unusually sensitive. On the other

hand, with the knife-edge at f , no flat is necessary. The aberrations are greatly magnified, but the depth of focus is also magnified the same amount, so that it seems reasonable to suppose that the test is no more sensitive with this arrangement, even with a fine enough source.

The correction of an under-corrected mirror can be found by measuring the distances of f and f' at which the mirror appears flat, and using the first of equations (2)

$$N = 1 - \frac{2R}{(a + c) + (a - c)} \quad (3)$$

Equations (2) can also be used to find the minimum distance of an artificial star for testing a Newtonian primary, by letting $100(1 - N)$ equal the maximum percentage tolerance of figure. For example, a 6" $f/8$ could be figured flat to the knife-edge with the source as close as 30' from the mirror, and would still give excellent performance.

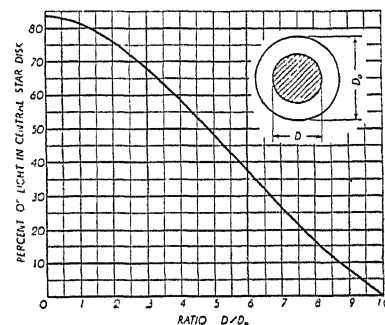


Figure 2: Percentage in central disk

A word should be said about the accuracy of equations (1) and (2), and the tolerances in figuring the mirrors. Kirkham's equation (1) is probably accurate enough for any system of reasonable dimensions. Trigonometrical ray tracing shows it to be correct to less than 1 percent of N for an 8" $f/12$ system with an $f/3$ primary, and again for a 10" $f/19$ with an $f/5$ primary. Equations (2), also owing their simplicity to binomial expansions, hold to the same order of precision. The tolerance of figure for a Cassegrainian primary is the same as if it were to be used for a Newtonian, and can be found from the table given by Wright in "A.T.M."; that is, the correction N , expressed in percent, may vary by the amount given in the table. The secondary may deviate from a true sphere by a quarter of a wavelength or half a fringe, provided the primary is perfectly figured, and should be tested by interference against its polished and figured tool*, or by the King test if optical glass is used. The above tolerances are for half of the Rayleigh quarter-wave limit, since the optical path error can be reduced to a quarter of its extreme value by proper focusing. Even the keenest observer can detect no departure from perfection of the image produced by a system corrected to within half of the Rayleigh limit.

If the optical parts have been fig-

* A fluorescent lamp makes a fairly satisfactory light source for interference testing, although the fringes are not so dark as those from a sodium or mercury lamp.

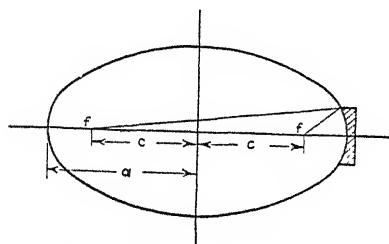


Figure 1: Kirkham's ellipse test

optical surface for testing, and at the same time avoiding the difficult task of figuring the hyperboloid. To compensate for the aberration introduced by the secondary mirror, the primary is left undercorrected by an amount depending on the dimensions of the system, in accordance with the equations given by Kirkham (Sci. Am., June 1938). These equations may be combined and rearranged into a form possibly more suitable for calculation:

$$N = 1 - \frac{4p^2}{RR'} \left(\frac{p' + p}{p'} \right)^2 \quad (1)$$

where N is the fractional correction, R the radius of curvature of the primary, R' the radius of curvature of the secondary, p and p' the lengths from the secondary mirror to the primary

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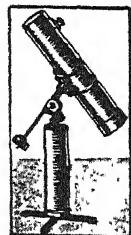
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ured correctly, and the system properly collimated, the only reason for any relatively inferior performance is the diffraction effect produced by the secondary. Many writers have expressed alarm at the amount of light thrown by such obstructions into the diffraction rings surrounding the central disk. Few have considered the quantitative aspect of the situation.

Two important effects are produced by the obstruction from the secondary. The most noticeable, of course, is the loss of light from the central disk and the enhancement of the first few bright rings. Assuming perfect optics, no spider diffraction (which is negligible, anyway), and that the obstruction is centered and circular, Figure 2 shows the amount of the total image light remaining in the central disk for various sizes of obstruction. (Strictly speaking this holds only when the obstruction is directly over the objective, but the effect of placing it several feet in front of the objective is practically the same.) Note that, with no obstruction, about 84 percent of the light is in the central disk. Now Conrady ("Applied Optics and Optical Design") has pointed out that, in the average case, at the Rayleigh limit this figure drops to about 68 percent. At double the limit, only about 40 percent of the light remains, but up to this point the size of the disk has not increased appreciably. Thus, considering Figure 2, a good reflector with a 25-percent-diameter obstruction would be at least as good as a refractor corrected to the Rayleigh limit. However, beyond apertures of about 5", the secondary spectrum of the ordinary f/15 refractor exceeds the Rayleigh limit for chromatic aberration. Even allowing for the decreased sensitivity of the eye for the scattered

The net result of the diffraction is, of course, to obscure detail of very low contrast which is near the limit of resolution of the telescope, the bright rings from points at the edge of a bright area overlapping the disks from a relatively darker area. Since, for moderate sizes of obstruction, it is the first bright ring which will cause trouble, a rough indication of its effect may be obtained by considering the intensity of the brightest part of the

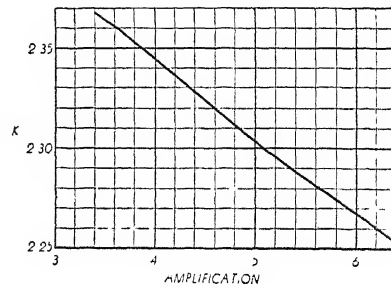


Figure 4: To find N, first choose or calculate the amplification, which is given by p'/p . From the graph, find the corresponding value of K. Multiply this K by p/R , and subtract the result from 1. That is, $N = 1 - Kp/R$. As an example, take the system given by Hindle in "A.T.M." Here $R = 120$, $p = 15$, $p' = 60$, and the amplification is thus 4. Hence $N = 1 - 2.345 \times 15/120$, or about .71. Of course, the system could no longer be used as a Newtonian or Gregorian in the usual way.

ring as compared to the intensity at the center of the disk. This is shown in Figure 3. It is seen that the secondary may be almost a third of the diameter of the primary before the ring has more than 5 percent of the intensity of the disk. At this point in the discussion physiological factors enter, but it would seem unlikely that the average person could detect any difference, in changing to a perfect refractor where the ring is about 2 percent as bright as the disk. All in all, one may conclude that the diffraction rings, so noticeable around bright stars, are not nearly so harmful as they would appear.

Thus the modified Cassegrainian, while admittedly somewhat harder to make than a long-focus Newtonian, is not a very formidable project. The secondary involves only a sphere, the easiest of optical surfaces to make; the primary, since testing involves no zonal measurements, should be actually easier than the common Newtonian primary. Combined, the two make a compact and powerful instrument whose performance will leave little to be desired.

GARAGE door becomes an alt-azimuth mounting for a Newtonian reflecting telescope in the yard of F. L. Frazer, 1016 Seventeenth Avenue North, St. Petersburg, Fla. Through the door, near the outer edge, is a horizontal axle, the telescope's horizontal axis. Vertical axis then is the hinges of the door, which may be swung as a door usually is swung.

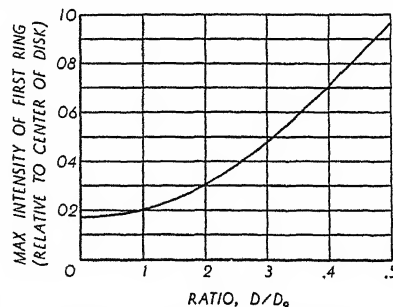
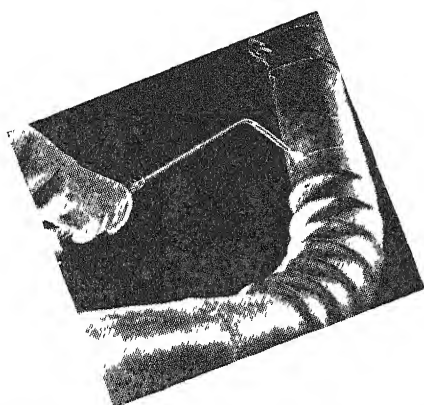


Figure 3: Intensity comparison

colors, it is hard to see how a large refractor could perform as well as any reflector of the same aperture; a long-focus Newtonian with its very small flat should be far superior.

The second effect is a favorable one. As the size of the obstruction increases, the actual diameter of the central disk decreases, becoming about 80 percent of the normal size for a half-diameter obstruction, and about 75 percent normal size for a three-quarter obstruction. This effect serves to compensate for the increased brightness of the rings by increasing the resolving power of the instrument. In fact, with a three-quarter-diameter disk over the center of the objective, it is quite possible that the Dawes limit could be exceeded.



INDUSTRIAL DRAMA Oxygen, subject-matter of the article starting on page 101, is the life breath of the ubiquitous oxy-acetylene flame. Here such a flame is being used in the "wrinkle-bending" of large pipe. The pipe wall is heated and pressure applied to make bends of any angle in pipe of almost any size. Photograph courtesy The Linde Air Products Company

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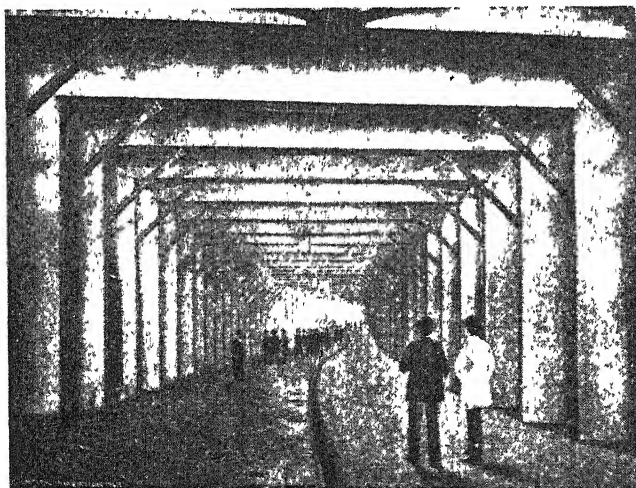
50 Years Ago in . . .



(Condensed from Issues of September, 1896)

TECHNOLOGICAL UNEMPLOYMENT—"It is, no doubt, true that when a new invention is introduced which revolutionizes some particular art or branch of business, it at first decreases the number of persons employed in that particular line; but that is only temporary, for in a short time the result is a cheapening of the product, a greatly increased demand for it, because of this cheapening, and then necessarily an increased demand for laborers in that line, and almost universally at increased wages."

BOSTON SUBWAY—"Many years ago it became apparent that Boston required additional facilities for the transportation of street car passengers through the lower parts of the city. In order to have the tunnel near the surface, and in order to avoid lateral pressure, the tunnel has been given a flat roof, supported by brick arches turned between heavy I beams. The sides are of similar construction, the I beams in the sides standing vertically. Our cut illustrates a two-track subway. Part of it, however, will be wide



THE BOSTON SUBWAY INTERIOR OF THE TWO-TRACK SUBWAY.

enough for four tracks, side by side. The two-track subway is 24 feet wide, and the four-track one is 48 feet wide. . . The ventilation problem has been much simplified by the determination to use electric traction. It is proposed also to have a fan for every 600 feet section of the subway."

AERIAL PHOTOGRAPHY—"William A. Eddy, of Bayonne, N. J., has succeeded in making several distinct photographic views of Boston from a great height, by means of a camera supported from kites. The kites were of the tailless type used at the Blue Hill Observatory, where an altitude of 7,441 feet was obtained, and were six and seven feet in diameter. Four to eight of these kites were required to support the camera, depending upon the strength of the wind."

GERMAN INDUSTRY—"Perhaps the most notable fact in the industrial world just now is the commanding position which is being won by the German manufacturers. . . Her industrial triumph, which has come as a surprise to the world at large, and with a rude, awakening shock to Great Britain in particular, is no surprise to the German people themselves. In school and college, in workshop and factory, by carefully planned organizations at home and abroad, they have set in motion a system of industrial forces which

are now working out the desired results with mechanical regularity and precision. Germany owes her industrial success to her system of scientific training in schools and colleges, to the close fellowship which exists between her factories and her schools, and to her elaborate organizations for the control and development of commerce."

PATENT MEDICINES—"Of all the so-called patent medicines, very few are really patented at all, and they are supposed to be, and often are, of unknown and secret composition. Protection by patenting, which involves disclosure of their composition, is the last thing their proprietors would think of. It is such secrecy that is opposed to every fundamental principle of medical ethics."

ROLLER SHIP—"Shipbuilding and naval circles are interested in a new type of vessel which has recently been launched in France. It is called the Ernest-Bazin, and, in brief, it consists of a rectangular iron frame or platform (carrying deck houses) about 120 feet long and 40 feet wide, mounted on six hollow lenticular rollers, each some 39 feet in diameter. . . Only one-third of each roller is submerged. A 550 horse power engine actuates the screw propeller, which rotates in an inclined plane between the pairs of rollers."

TRANSCONTINENTAL—"At noon on the twenty-fifth of August, a war message and a post office dispatch were entrusted by the government authorities to a bicycle relay for transmission across the great American continent. Thirteen days later the last of the 220 couriers reached New York, the eastern terminus of the trip and unslung the scarred and weather beaten wallet from his shoulders, the distance of 3,400 miles having been covered at the average speed of about 11 miles an hour."

COINS—"Advices from Washington, D. C., state that experiments with pure nickel and aluminum as substitutes for the present nickel pieces and one and two cent bronze pieces will be made at the mints."

100 Years Ago in . . .



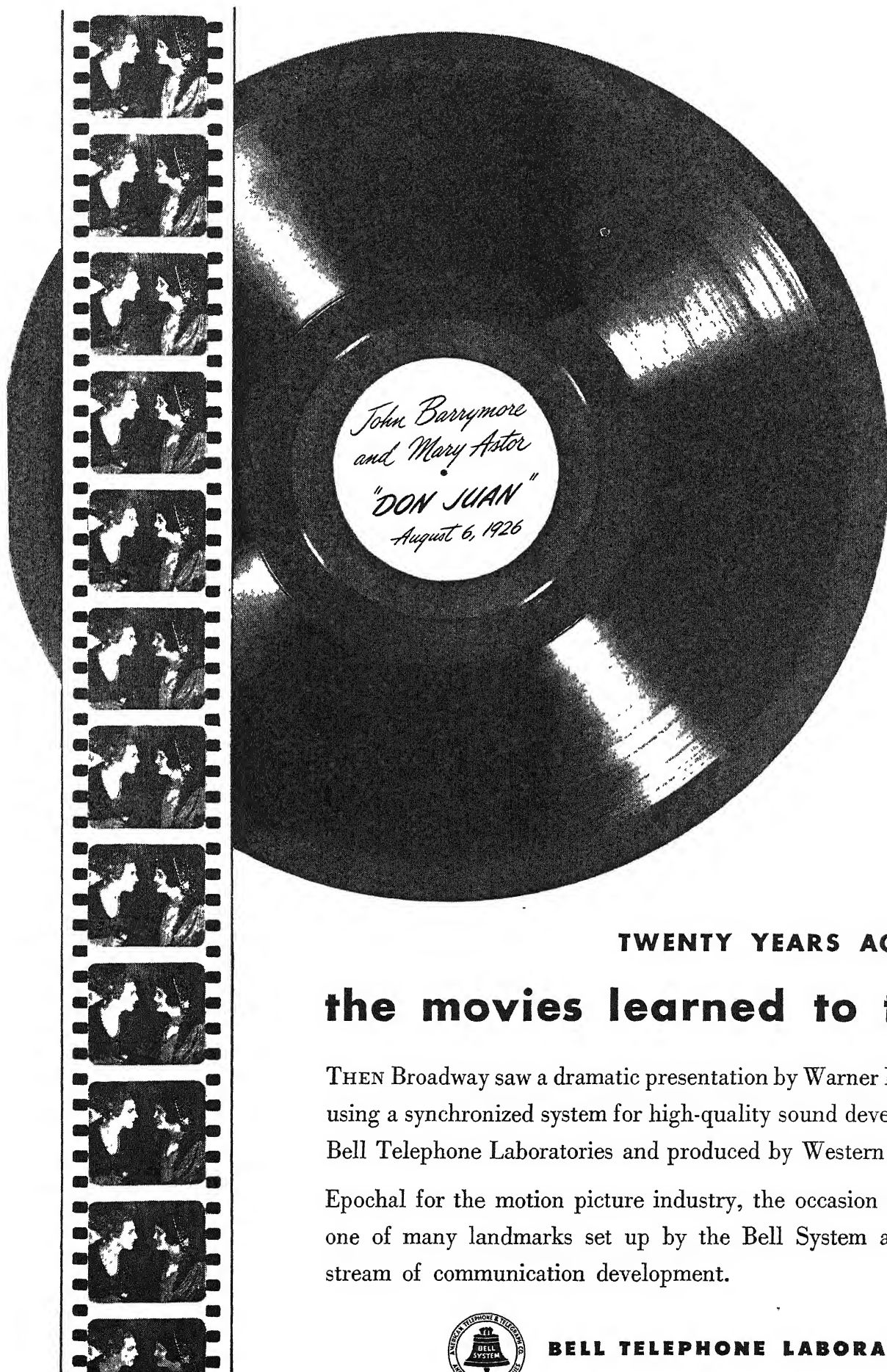
(Condensed from Issues of September, 1846)

FRENCH RAILROADS—"A Paris letter says that when the 2,619 miles of railroad, now constructing, can be added to the 906 miles already completed, France will possess three thousand five hundred and twenty-five miles. . . Every city in the kingdom will be within a day's journey of the centre of power and movement."

INVENTION AND PRACTICE—"It is a matter of wonder to the present generation, that many of our most useful and indispensable inventions in machinery, were not introduced to practical use for ten, twenty, or fifty years after they had been discovered, and their utility demonstrated—among which are steamboats, railroads, and locomotives."

FORESTS AND RIVERS—"That remarkable man, Humbolt, has reduced it almost to a demonstration, that the streams of our country fail in proportion to the destruction of its timber."

BRIDGE—"The railroad bridge at Deerfield, Mass., is said to be a splendid affair. It is fifty feet above the traveled stage road bridge, and nearly eighty feet above the waters of the river. The piers are already erected, and nearly ready for the superstructure."



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Previews of the Industrial Horizon

STYMIED PATENTS

SEVEREST physical blow ever suffered by the United States Patent Office was dealt at the outbreak of the war when the examining divisions were removed from their specially designed offices in Washington to an old tobacco factory in Richmond, Virginia. Divorced from the public research room and from their invaluable scientific library, the examiners were forced to struggle along as best they could, handicapped by inadequate quarters, lack of reference material, and the necessity for vastly increased correspondence plus arduous trips between Richmond and Washington.

All this could be put up with under war-time conditions. But the situation is still at a stymie. A start was made to re-consolidate the Patent Office. Red tape entwined the procedure. About half the examining divisions were returned to Washington. The rest remain in Richmond. No one knows what is to happen next. The cumulative effect on the morale of the examiners is obvious.

More important, however, is the effect of this official stymie on the issuance of patents themselves. Today industry is grasping for new ideas, new products, essential to peace-time progress. And with the Patent Office in the tangle of war-time hinderances, protection for these new ideas is being held up. When everyone is looking to the Patent Office for inventions that will speed production and operate to keep prices down, the Patent Office is found split in twain, inefficient, and unprepared for its vital part in the post-war era.

Here's how the situation stands at the time of writing. Over 11,000 applications await consideration by the Patent Office. Each week the Office falls more than 500 cases further behind. Unless something is done—and done immediately—to alleviate this situation, it will soon be that only a young inventor can expect to live long enough to see his patent issue and to enjoy the benefits of the full life of the patent grant.

The need is obvious. The course of action is equally so. The Patent Office must be consolidated, returned to its pre-war efficiency. If this is not done, the progress of peace-time technology will be so greatly hindered as to act as a brake on the wheels of industry.

Our patent system is good. This has been proved beyond question. But when it is held up mechanically so that it can function only in an inefficient manner, then the time has arrived for action. There is no reason why the Patent Office cannot be restored to its former quarters, with all the advantages that lie there. Let's get it done and done *now*, so that industry, inventors, and the consuming public alike can benefit from American genius.

STATIONARY POWER

STEAM, hydro-electric, and Diesel are the three forms of stationary power that are of main interest to the industrial user. The first two are old standbys, the third is a relatively new-comer that has to win its spurs in each individual case before it is accepted.

Already there are between five and six million installed horsepower of stationary Diesel engines in use in the United States. They are used by municipal power plants, private utilities, oil pipe lines, cotton and oil mills, the grain industry, in the manufacture of ice, and so on. In every case the Diesel has more than proved its ability to compete with other forms of power on a cost and efficiency basis.

On the horizon can be seen clearly a continually increasing use of Diesel power in stationary plants. Modern design shows trends towards engines which are suited to jobs that could not be done economically by the older and more cumbersome units. Particularly is this the case where installation is to be made in city buildings. The high-speed Diesels now being produced offer advantages of reduced space requirements as well as a decreasing neces-

By A. P. Peck

sity for vibration isolation. These factors, coupled with the simplicity and economy of the Diesel, are bringing this prime mover into greater prominence in many fields of industry. Diesel manufacturers are well aware of the possibilities ahead of them; if developments of the Diesel continue to keep pace with the opportunities for its use, the power-consuming public will come to depend more and more on these engines.

LATEX—NATURAL OR SYNTHETIC?

MILK of the rubber tree, latex can now also be called milk of the synthetic rubber factory. And in considering the future uses of latex, distinction must be made between the natural and the synthetic product.

At the present time—and disregarding the political aspects of rubber—synthetic latex holds the edge on price and availability. Whether this will hold true two years, or even a year, hence is not seen in our crystal ball. However that may be, synthetic latex has the advantages of resistance to oils, greases, and many acids.

Pre-war, latex uses were largely confined to foam products such as cushions, surgical goods, toys, and coatings for tire cords. Now chemists have developed other uses which include, besides former applications, paints, textile and paper coatings, adhesives for a wide range of purposes, mechanical rubber goods formerly made exclusively from hard rubber, and a host of other articles that must be water- and airtight.

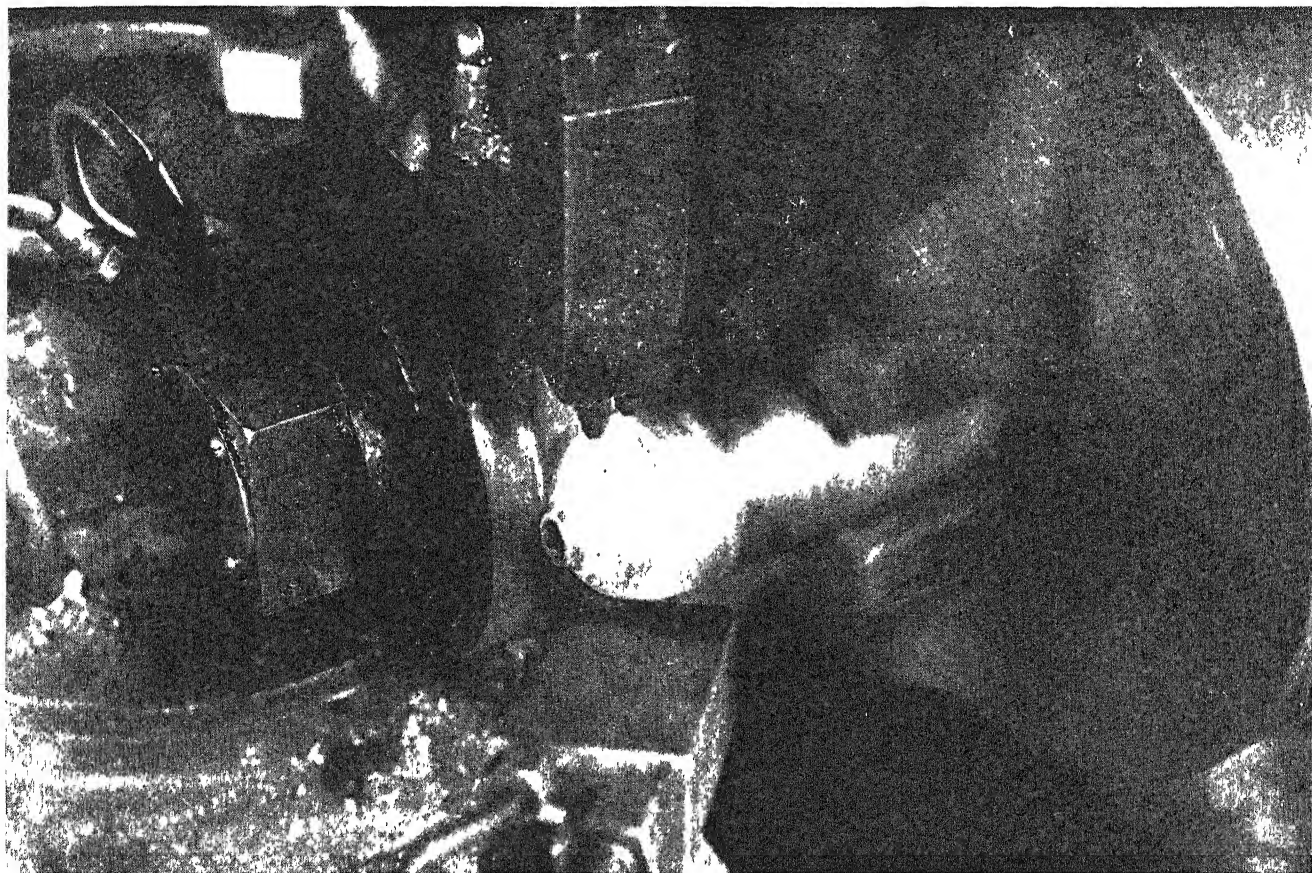
Synthetic-rubber production facilities in the United States, and the superiorities of synthetic latex, point to a battle royal between synthetic and natural rubber milk. It is a battle fraught with many possibilities. Our money rides on synthetic because of its availability within the confines of the nation, its inherent advantages, and its innumerable applications that can (and have) come out of the test-tubes of the chemical laboratory.

CONCRETE FACTS

CEMENT, aggregate, and water make concrete. But concrete is not always as simple as that. Witness, for example, the expanded funds and facilities made available recently by Portland Cement Association for research and development in the field of cement and concrete use. The findings that stem from this work, an acceleration with over 30 years of background, will be made freely available to engineers, architects, contractors, builders, and the general public.

FOR FUTURE REFERENCE

RAYON, with production up some 600 percent since 1930, is looking for new worlds to conquer; watch it hold its place in tire cord construction and whip the bad name it has made for itself in men's clothing, shirts, and underwear. . . Any industry that uses water and does not concern itself with problems of preventing pollution of streams, lakes, and oceans, is heading for real trouble with the public at large and the health authorities in particular. . . Frozen foods are seen as a huge future industry, far greater than the refrigerator at the corner store; bidding for part of this big business are improved packaging for the foods, door-to-door delivery in refrigerated trucks, and expanded locker-plant facilities.



Oxy-acetylene flame spinning, supplanting deep drawing for many operations, will close tubing ends or reduce diameters at any point. Practicality of such methods requiring intensely hot flames depends to a large extent on low-cost oxygen of highest purity

ENGINEERING

Oxygen For Industry

By EDWIN LAIRD CADY

The Uses for Pure Oxygen in Industry have been Growing for Years—
Now they are Growing Even Faster. To Meet the Demand for this Hard-
Working Gas, New Methods of Transportation, Plant Distribution, and
Even Manufacture Within the User's Plant are Steadily Being Developed

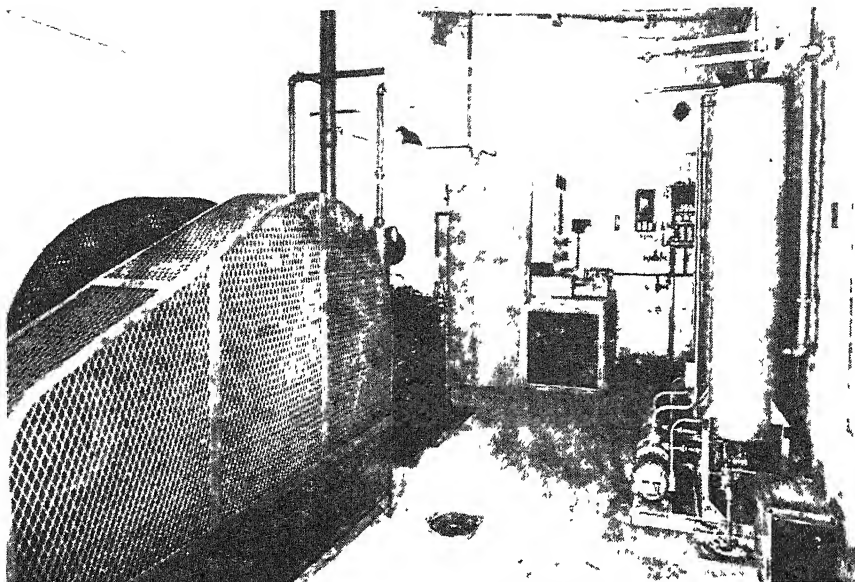
EVERY hour some 10,000 cubic feet of oxygen are being produced in the steel mills and other large plants which use it. Just a few months ago, all such gas would have been brought in cylinders from the special factories which produce oxygen or, perhaps, would have been kept at some 300 degrees below zero,

Fahrenheit, and transported as liquid oxygen in tank cars.

This 10,000 cubic feet per hour of 99.5 percent pure oxygen is not much as the oxygen business goes. On the basis of a 2000-hour work year, it adds up to only 20,000,000 cubic feet a year, or less than one out of every thousand of the more

than 22,000,000,000 cubic feet of oxygen which industry used during every war year.

But the important point is that generation of oxygen right on the job can make one more reduction in the cost of the gas at the flame tip or the nozzle. And every time the cost of oxygen at the point of work



Courtesy Air Products, Inc

• LOOKING AHEAD •

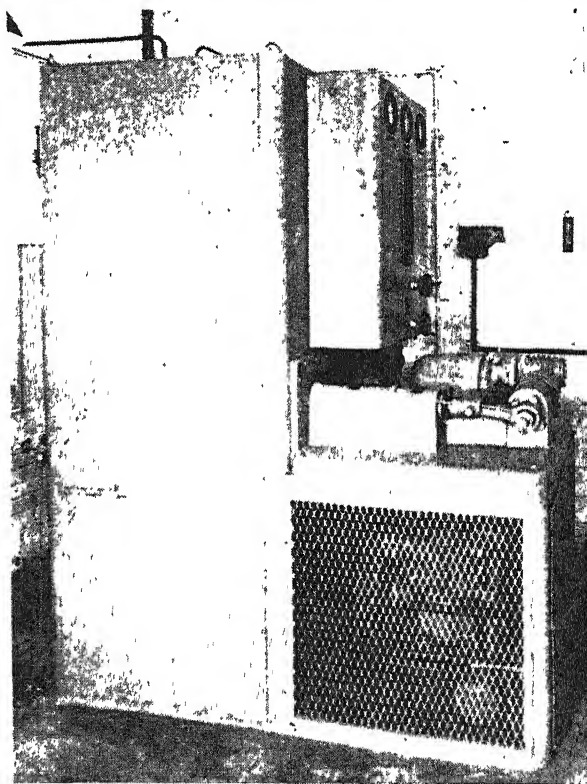
Costs of oxygen will be cut. . . Large-scale uses will expand, bringing increased production capacity to blast furnaces, as one example. . . Liquid oxygen may become practical for smaller plant use. . . Oxygen produced at point of work will expand possibilities, especially in larger plants. . . Synthetic jewels from oxy-hydrogen furnaces. . . New discoveries of uses for by-products of gas production.

goes down, the use of oxygen goes up. And the industrial use of oxygen is due for a further boom.

LOW COST: NEW USES—Strange to say, the basic method of producing oxygen has not changed much in the past century. Air is chilled by expanding it through a series of heat exchangers, each of which cools it more until it gets cold enough to become liquid air. This liquid air is allowed to rise in temperature at carefully controlled rates. Each of the gases of which air is composed—nitrogen, oxygen, helium, and argon—boils from the liquid at a different temperature and so may be collected while the liquid is held at that temperature. Oxygen comes off at minus 297.2 degrees, Fahrenheit.

The makers of oxygen have gradually improved this process, increased efficiencies, passed savings along to consumers. And the consumers in turn have used more and more oxygen. In 1921, a little more than one billion cubic feet were produced and the selling price averaged about \$1.30 per hundred cubic feet. With the average price in 1944 down near \$0.55 per hundred, the volume

Oxygen-producing plant (above) consists of air compressor at left, air purifier at right, and air separator in background. Latter unit (right) is comprised of air drying, liquifying, and distillation equipment, plus the oxygen compressing system. As yet, such plants are of greatest value to big industry



was up above the 22 billion cubic feet.

A lot more had happened than the Adam Smith formula of "down with the price and up with the volume." Makers of oxygen and of oxygen-using equipment had put into the field some of the best sales-engineering forces ever to co-operate with industry. These men worked out use after use, are still working them out. The new oxygen uses made the markets, the markets demanded the volume, the volume brought the price down. Thus was an industry built out of thin air.

Most of the new uses sprang from the fact that almost any operation which needs flame temperatures can be done better if pure oxygen is

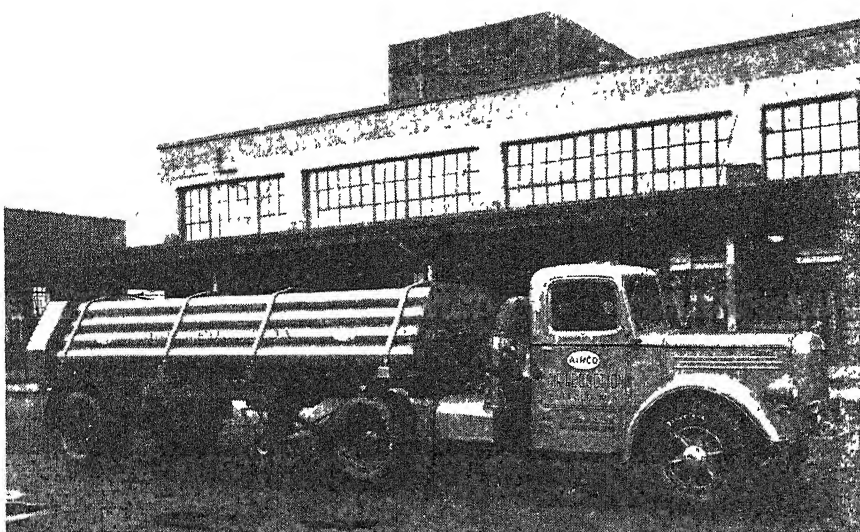
used in the flame. With pure oxygen, not only can steel and metals be burned like fuels to supply the heat for their own melting, but also the flame and the application of heat become more controllable. Heating becomes less of a black-smith shop operation and more of a precision-tool one.

Flame welding and simple flame cutting were followed by flame scarfing, gouging, skiving, stack cutting, priming for paints, and a multitude of others. But many a fully developed operation had to wait for oxygen's point-of-use cost to go down before it became commercially practical. Many operations still wait.

TRANSPORTATION HIGH—Sticking up like a mountain which every such cost reduction must cross is

the problem of transporting oxygen from its point of production to its point of use. The situation is so complex that no one seems to have any real figures on it. Best obtainable estimates are that transportation costs are at least 60 percent of all costs to oxygen users. They may be even much higher than that.

The simple cylinder, familiar to almost everyone, is the most common means of transporting oxygen. It weighs about 150 pounds when full and 130 pounds when empty. That means shipping 130 pounds of steel from the producing plant and back in order to get 20 pounds—244 cubic feet at 2200 pounds pressure—of oxygen to the job. This is equivalent to shipping 260 pounds



Large, multi-tank trailers are connected to plant oxygen manifolds—usually two trailers are used, one as a standby. Such equipment boosts oxygen uses

one way, and the figures show that more than one pound of steel has to be shipped from the generating plant to the user for every cubic foot of oxygen bought in those cylinders.

Such a cost is not too bad for garages and small welding plants which use oxygen for a few highly effective operations and can well afford to pay \$1.00 or so per hundred cubic feet and then add the transportation costs. But in a steel mill or a large glass-making plant, the oxygen cost has to get down as low as 60 cents or even clear down to 25 cents per hundred cubic feet before some of the most important oxygen-using operations can be practical, and the delivery costs have to be proportionately low.

One way to reduce these costs has been the trailer truck which has built into its body several cylinders, each of which holds far more than 244 cubic feet of oxygen. These trailers are made in different sizes and capacities to suit the needs of various oxygen users. At least two trailers are kept at every plant that buys its oxygen this way; one trailer at a time is emptied into the plant distribution system so there almost always is a full trailer standing by.

Another advanced method is to ship the oxygen in liquid form, thus getting far more into the same shipping space. On a pound-for-pound basis this method can get down to one pound of steel for each pound of oxygen as compared to the 6.5 pounds to 1 ratio when oxygen in gas form is shipped in the simple cylinders. No one knows how far this liquid oxygen method will be carried. It has proved highly practical and economical when the liquid is shipped in tank cars. Experiments are under way with handling it in

cylinders no larger than the common ones which now hold no more than 20 pounds of oxygen in gas form. Liquid oxygen may yet solve problems and save money in the smallest of machine shops.

PLANT DISTRIBUTION—When the oxygen in its containers reaches the user's plant it still is not at the point of use; it has to flow through pipes or hoses to the point of use. And this can present problems.

First of all, the oxygen must not be contaminated. It is 99.5 percent pure when received. The addition of any contaminant such as water vapor sufficient to reduce this to only 99-percent purity can reduce by 25 percent the effectiveness of the oxygen for metals cutting. The distribution system has to be clean

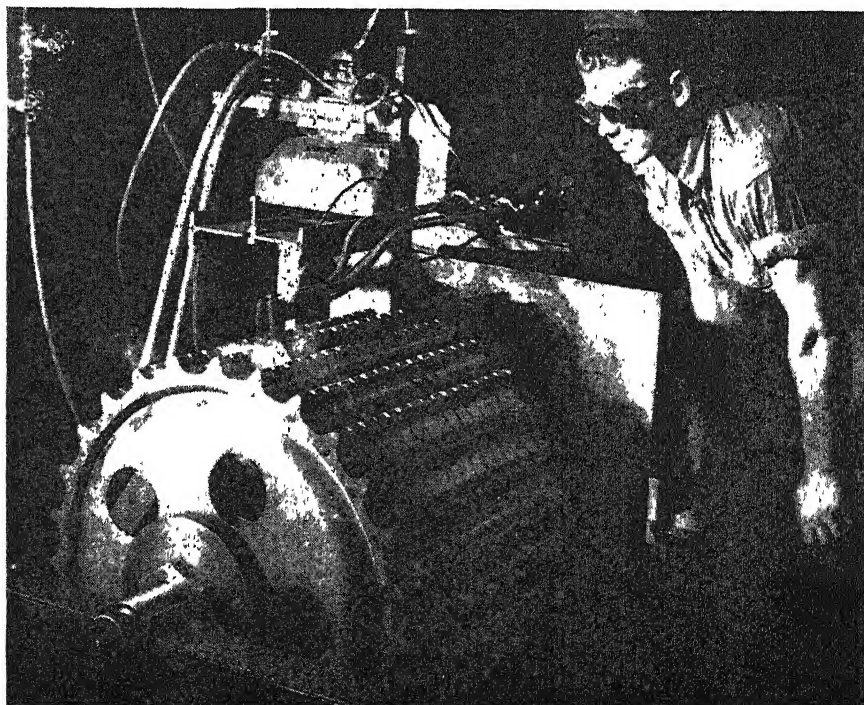
Secondly the oxygen must be kept from leaking. Oxygen in itself is not dangerous. But if it leaks to where any oil or grease will come into contact with it, and especially if it is released in a room which contains oil fog from metal cutting machines or from the lubricants of high speed shafts, then a fire and even explosion hazard may be created. And, of course, the oxygen in the pipes commonly is at high enough pressure to be dangerous if the pipes are mechanically damaged.

The simple cylinders are easy enough to handle. They may be individually mounted close to their points of work and the gas run through fairly short hoses. For this reason, quite a few of these cylinders are likely to be found even in the plants of the largest users. Despite their extra transportation costs they can save materials-handling costs in getting the gas to places in the plant where only a little is used.

Gas from the trailer trucks, and from gangs of the simple cylinders, often is fed to manifolds and from these to pipe lines throughout the plants. The pipe lines must be ample in size both to maintain the pressure and to permit the flow of gas with a minimum of frictional losses.

Steel pipe commonly is used because of its strength. So far as is possible all joints are welded. Threaded joints must be gas tight, doped with materials which contain no oils or greases. Pipe interiors must be perfectly clean.

The gas pressure in the cylinders or other containers is sufficient to keep up the operating pressures in the distributing pipes, and these in



Flame hardening tractor-drive sprockets—a typical oxygen-using shop process

turn are regulated by automatic regulators. Makers of oxygen are careful about recommending pipe layouts which will supply adequate pressures at all work points, and specifying the number of cylinders or other containers which must be connected to a manifold at any time to assure adequate flow. Usually there are two or more banks of cylinders so one may be working while the other acts as a stand by.

One cost problem with many oxygen-distributing systems is that they are obsoleted long before they are worn out. Oxygen, once used in a plant, has a way of finding more and more uses. A high proportion of distribution systems are now so over-loaded that they need complete re-building for higher capacities

HOME-MADE OXYGEN — The method of producing the oxygen right in the plant of the user avoids the problem of transportation, but not that of distribution. Generating plants for this purpose require only 100 square feet of floor space but at present are not practical unless the user needs at least 500,000 cubic feet per month. Plants suitable for only 200,000 cubic feet per month are on the drafting board, but even these will not mean much to any but the larger consumers.

Effects of these new plants, and of some of the new methods of low-cost distribution from the plants of the oxygen makers, are more likely to be greater expansion of the uses of oxygen rather than heavier competition for present uses.

Blast furnaces, for example, can have their production capacities increased by as much as 20 or even 30 percent by the use of pure oxygen in their air. This would take more oxygen than anyone seems ready to supply for such a purpose right now, and would require the gas to be supplied at extremely low cost.

Cheap commercial gas can be made from coal by the use of pure oxygen; a new battle of the fuels—oil *versus* gas *versus* solid fuel—may be in the making. Pure oxygen is used to produce high-octane motor fuel from natural gas, in the manufacture of nylon and other plastics, and in the removal of sulfur gases from petroleum and many other products.

Pressure welding, and its twin process pressure upsetting, both depend upon the use of pure oxygen. Heat and pressure are applied simultaneously to the area to be welded or upset, but that heat is controlled so exactly that the metal becomes plastic but does not melt.

Welds so made can be heat treated, after which not even a microscope will find the actual weld.

Synthetic corundum, sapphire, and other products can be made in oxy-hydrogen furnaces. Development of such furnaces was rapid during the war, but even so they can hardly be said to have passed the infancy stage.

Oxygen is only one of the useful gases taken from the air. To date it is the most widely employed one, the others mostly being considered as by-products. But more and cheaper oxygen, with the distribution-costs problem being reduced, means lower costs and more uses for nitrogen too. Hundreds of old processes may be improved, hundreds of new ones born, by giving more oxygen to industry.

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself.

The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

AIR CONTROL

*Reduces Cost Through
Precise Design*

WITH factory equipment arranged more compactly to reduce the problems of materials handling, and with every machine operating at higher speeds and capacities than ever before, the necessity of exhausting dust-laden and otherwise fouled air is continually increasing. In addition, winter needs for heating and summer needs for air conditioning are making the evacuation of any more air than is necessary an expensive luxury.

As a result, the old method of making sure that the evacuation system had enough capacity—and not worrying too much if it had a gross over-capacity—is being discontinued. Duct capacities, fan and blower sizes, and air speeds are being worked out to match evacuation needs exactly, with just enough over-capacity to provide an adequate safety factor.

To preclude such carefully balanced systems becoming leaky, clogged, or inefficient, portable testing instruments have been devised that will reach into out-of-the-way places and give instant checks on air speeds in feet per minute. Liter-

ally, such instruments will save production workers and their supervisors many a headache.

PRECISION COOLING

*Controls Contraction to
Form Holes Accurately*

THE use of fixtures to establish precise dimensions on materials and parts which must be cooled from liquid or plastic states is an industrial method which seems to have sprung from a number of sources and to be rapidly growing in as many directions.

Most materials contract when cooling. If prevented from contracting on some bores or other interior surfaces, they can be held stable on those dimensions while the forces of contraction are diverted to other directions.

Plastics and some of the softer and more ductile metals are therefore allowed to contract upon accurately made and placed steel pins or other shapes. Holes so made can be held to plus or minus .0002 inches without further finishing.

Ceramic cores also are used for this purpose. These will withstand the temperatures of the molten materials without serious deformation. Some are later knocked out with air hammers. Other cores, of shapes too complicated or used in parts too weak for hammering, are made of materials which can be dissolved out in caustic soda.

BELOW-ZERO TECHNIQUES

*Improve Machine Work,
Castings, and Lubricants*

LOW-TEMPERATURE mechanical engineering begins at about 50 degrees below zero, Fahrenheit, and goes on down to minus 300 degrees and lower. It exists because some assemblies can be made more readily if parts are cooled and shrunk, and because some metals and other materials can be machined, upset, or otherwise fabricated much better at low temperatures.

Primary method of achieving these temperatures is by simple refrigeration. The parts are placed in mechanical coolers, kept there until chilled, held there until needed.

A method now coming into use is chilling by liquid nitrogen. There are whispers that liquid nitrogen actually is being used as a cutting oil on top-secret production lines.

The cold techniques have grown large enough so that some of the largest makers of special castings are producing new alloys which have high strengths at low temperatures, and lubricants makers are giving the field special and concerted study.

Conducted by D. H. KILLEFFER

Take A Grain Of Sand . . .

SILICONE chemistry has been described as a new continent, lying between the mineral silicates such as glass and clay on the one side, and plastics on the other. The analogy is well taken, for the silicones actually do partake both physically and chemically of these thoroughly dissimilar types of materials. Chemically, a silicone polymer is a network of silicon and oxygen atoms just as in sand or quartz, but attached to the silicon are hydrogen groups derived from petroleum. These groups modify the properties of the silica network, thus giving the materials certain properties of liquids or of plastics.

Physically, the silicones bear little resemblance to sand except that, because they share the same basic structure, they are extremely resistant to heat.

The Corning Glass Works started to experiment with silicones as long as 10 years ago, hoping to develop glass-like plastics or other materials which would be useful in conjunction with glass. Results were so promising that they joined forces with the Dow Chemical Company, who had the chemical manufacturing technology, in the formation of the Dow Corning Corporation to manufacture the new materials. General Electric Company was also pursuing the investigation of silicones independently, and both groups have brought out commercial products within the past few years.

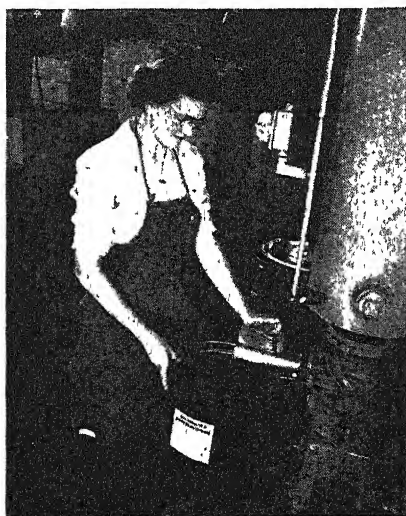
SILICONE LIQUIDS — Depending upon the method of manufacture, the silicones vary in physical properties from water-thin liquids to glassy resins. The liquids themselves can be made in wide ranges of viscosity and volatility. In this respect they are comparable to liquid petroleum distillates, which range from light, low-boiling naphthas to heavy lubricating oils. Before the war the new liquid silicones were laboratory curiosities, chiefly in-

Chemical Marriage of Sand and Hydrogen has Produced a New Family—the Silicones. In Liquid, Rubber, or Resin Form, These Unique Hybrids Combine the Heat Resistance of Quartz with a Variety of Other Special Capabilities Including Water Repellency, Insulation, and Lubrication

By HOWARD C. E. JOHNSON, Ph.D.
Chemical Editor, *Chemical Industries*

teresting for their unusual combination of properties. They are water-white, brilliantly clear fluids which remain liquid at temperatures as low as minus 40 to minus 120 degrees, Fahrenheit, and are stable up to 500 degrees, Fahrenheit. Liquid silicones are neutral, chemically inert, non-corrosive to metals, and highly resistant to oxygen and oxidizing agents, mineral acids, and corrosive salt solutions. Their flash points are higher than those of petroleum oils of the same viscosity, and—except for the very low-viscosity grades—they are non-volatile. Soluble in most organic solvents, they are insoluble in water and alcohol.

This combination of properties is



Courtesy Dow Corning Corporation
Silicon ignition-sealing compound on its way to a difficult job in high-tension leads and disconnect fittings

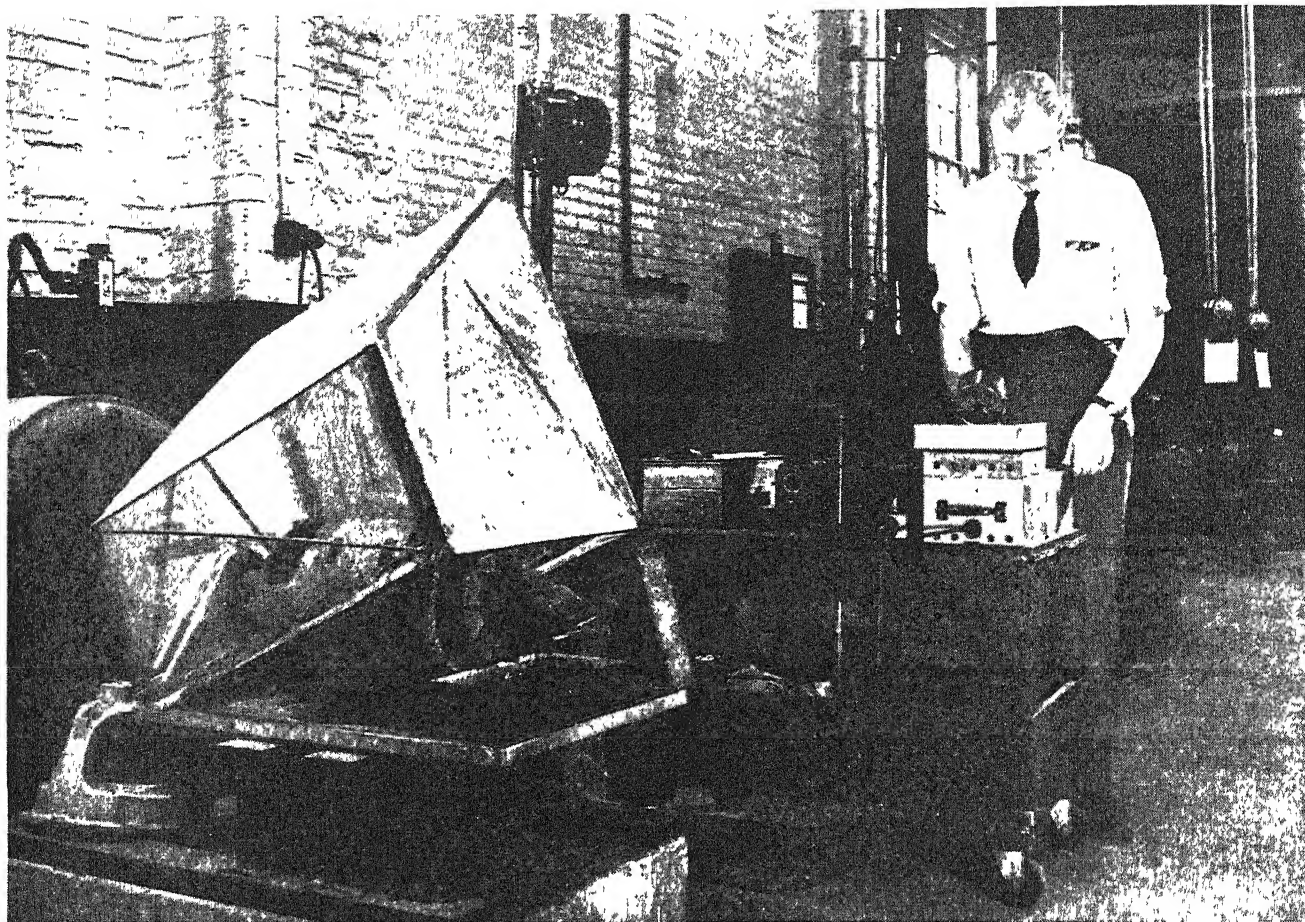
• LOOKING AHEAD •

Electric motors with lifetime insulation. . . Paints, plastics, and rubber that will resist high temperatures. . . Pastel automobile tires. . . Fewer power-line troubles with humidity-proof insulators. . . High-temperature greases for maximum motor outputs. . . All are possible now because of "modified sand"—the organic silicon compounds.

remarkable enough, but their phenomenal acceptance is due to three additional properties: For one thing, their viscosity does not change as much with temperature as petroleum oils, hence they do not "freeze" at winter temperature and get water-thin under heat. Secondly, glass, ceramic, and metal surfaces are readily wet by the silicones, thus making them water-repellent. The third property, the one responsible for their wide use in the electrical industry, is their extremely low electrical conductivity and resistance to voltage breakdown over a wide range of frequencies.

These remarkable qualities promise a wide use of silicone fluids as transformer oils, damping fluids, gage fluids, hydraulic fluids, and heat transfer media. It is quite possible that buildings may some day be heated more efficiently with silicone-containing radiators operating at 400 degrees, Fahrenheit.

Exceptional resistance to the corrosive action of chemicals has made



Test motor, operating through repeated cycles of high humidity and extreme temperature, proves serviceability of silicone insulation

the silicones useful impregnants of asbestos packings and gaskets in chemical pumps.

The silicones do not dissolve other plastics materials, and for that reason they are used to free plastics articles from molds, particularly in the injection molding of hollow articles.

To make surfaces water repellent, they can be treated with a solution of silicone in carbon tetrachloride or some other suitable solvent. When this is done, moisture does not condense on a treated surface as a continuous film but rather as minute, isolated droplets. Insulators so treated retain their high electrical resistance even under humid conditions.

An alternative method is to expose the surface to the vapors of the so-called chlorosilanes. These are the intermediates in silicone manufacture and react with water to form the final product. The chlorosilane deposited on the surface of the material reacts with moisture in the atmosphere to form a silicone film on the article. The process has been used chiefly on metal, glass, and ceramic bodies, but progress is being made in similarly treating paper, wood, and textiles.

The films obtained withstand

washing, dry cleaning, and even considerable abrasion. This process has been placed on a commercial basis by General Electric under the name "Dri-Film."

Still another special use has cropped up for the silicone liquids. In concentrations as low as 0.1 percent they inhibit the foaming of hydrocarbon lubricants. This manifestation of surface activity may again suggest new fields for these versatile materials

SILICONE RUBBER—The next step in the scale from liquids to solids is silicone rubber. During the research leading to this product, an experimental material, "bouncing putty," was developed which received quite a bit of attention in the popular press. The putty, however, lacked the ability to retain its form and was hardly more than a curiosity. Now, the newer material looks, feels, and, with one exception, behaves like the natural and synthetic organic rubbers. The exception is that Silastic, as the new material is called, retains its rubber-like properties at temperatures far above and far below the serviceable limits of the organic rubbers.

The remarkable resistance of silicone rubber to heat is the result of its quartz-like basic structure. Ordi-

nary rubbers contain what are termed unsaturated linkages. These linkages absorb oxygen very rapidly at high temperatures and cause the rubber to become brittle. Chemically, the behavior is exactly like that of linseed oil, another unsaturated compound, which "dries" upon exposure to air by absorption of oxygen.

Demands for elastic materials which would remain resilient and neither soften nor harden at temperatures above 250 degrees, Fahrenheit, remained largely unsatisfied until silicone rubber was introduced. Silicone rubber shows only slight changes in its properties from minus 70 to over 500 degrees, Fahrenheit. Under service conditions it does not deteriorate at continued exposure to 300 degrees, Fahrenheit. At the other end of the temperature scale it behaves just as admirably, remaining flexible even after 24 hours at minus 70 degrees, Fahrenheit. Some stocks can even be subjected to dry-ice temperatures and still retain their flexibility. One reason for these properties is that ordinary rubbers owe their low-temperature resilience to plasticizers, which are volatile with heat and soluble in organic solvents. Hence, if the rubber is subjected to heat or the action of solvents, its low-

temperature resilience is lost. Silicone rubber does not contain plasticizers, and consequently its properties are relatively permanent.

Since silicones contain no reactive centers—like the unsaturated linkages in the organic rubbers—it follows that silicone rubber is resistant to weathering, ozone, sunlight, and the other ills that beset natural rubber. The same water repellency that is characteristic of silicone coatings is also a property of silicone rubber. Therefore, the good electrical properties of silicone rubber are not affected adversely by humidity or even immersion in water.

Although silicone rubber weathers well and is certainly superior for extremely high or low temperature uses, its properties under ordinary conditions are comparable to those of the organic rubbers. Its resistance to acids, alkalis, and solvents is no better, and its tensile strength, and tear and abrasion resistance are lower. For this reason it is not useful for such applications as automobile tires.

In view of its cost and limitations, silicone rubber is no competitor with natural or synthetic organic rubbers except where resistance to extreme temperatures, ability to withstand oxidation, or good electrical insulation characteristics under severe conditions are required.

Among the uses already established are heat-resistant gaskets, diaphragms, and packings; impregnation of glass or asbestos fabrics for gaskets; coating conveyor belts for high-temperature service; coating glass tapes, wires and cables, and metals; embedding transformers; and fabrication of tubing, hose, rollers, pads, vibration mountings, and the like.

Silicone rubber comes in the form of crepes and pastes, and it can be fabricated by molding, laminating, extruding, and coating.

SILICONE RESINS — Still harder materials are the thermosetting silicone resins which have found their widest use in insulating varnishes.

The hard resin is simply dissolved in a suitable solvent, such as toluene, and used to coat magnet wire, impregnate glass or asbestos fabric, bond mica laminations to glass fabric, and to fill voids and render assemblies water-proof.

Here, the use of silicone varnishes instead of bulkier insulating materials makes it possible to decrease the overall size of electrical motors.

Two properties of silicones which make them especially suitable for insulating electrical equipment are their water repellency and resistance to heat. In a great many en-

vironments the chief purpose of insulation is to keep out water. Many organic varnishes are sufficiently water-repellent at ordinary temperatures, but they crack or become carbonized at high temperatures and then admit moisture. Silicones are inherently water-repellent, and because they are stable up to 500 degrees, Fahrenheit, or higher, they do not lose their desirable properties in service.

The use of silicone insulation permits as much as a 50 percent reduction in weight of electrical equipment where the operating temperature can be increased; and where it is desirable to maintain a lower operating temperature, the service life of the insulation can be greatly lengthened. For example, in an accelerated test at 590 degrees, Fahrenheit, one motor operated the equivalent of 2000 years at 320 degrees, Fahrenheit. The use of silicone varnish has therefore been hailed as the most notable advance in insulation since the advent of the electric motor itself.

Silicone resins have also been combined in enamels and heat-resistant paints. Formulated with titanium dioxide or aluminum flake, these resins give paints which are exceptionally resistant to heat and weathering and do not become yellow with age. The properties of these finishes are midway between ordinary organic coatings and ceramic finishes.

SILICONE GREASES — The advantages of higher operating temperatures for electric motors afforded by silicone insulation will only be fully realized when high-temperature lubricants are available. Progress is being made in this direction in research upon silicone oils and greases, and it appears likely that electric motors eventually will not only be silicone-insulated but also silicone-lubricated.

These greases, which are simply liquid silicones thickened with carbon black or metallic soaps, are extremely resistant to oxidation and to chemical attack. Silicone stopcock lubricants for laboratory use have already appeared on the market.

OTHER COMPOUNDS — While the silicones are the most dramatic of the organic-silicon compounds, there are others that deserve mention as well. One of these is ethyl silicate, which is the ethyl ester of silicic acid. It is useful as a source of amorphous silica and is used as such as a bonding agent for casting molds; as a preservative and a weather-proofing agent for stone,

brick, concrete, and plaster; in heat-resistant paints; in nitrocellulose and vinyl resins to improve adhesion to glass; and in the preparation of solid fuels.

Also, ethyl silicate will burn, giving off fumes of finely-divided silica "smoke." This fumed silica has the same physical properties as carbon black except, of course, that it is white. It can substitute for the carbon black which is so necessary in rubber to give it tensile strength and wearability, and in the near future it will be possible to make automobile tires of solid white or any pastel shade.

Other esters of silicic acid—especially tetraphenyl silicate and tetracresyl silicate—are being studied as heat-transfer agents for industrial processes. In the absence of moisture they are stable at very high temperatures. Another type of compound being studied for the same use is tetraphenyl silicon, which is chemically more stable.

The organic chemistry of silicon is truly a modern development. The first synthetic plastics was made almost a century ago, but the silicones were not even known in the laboratory until the turn of the century.

Even now it is too early to predict what will eventually be discovered in so virgin a field. Surely they will be used more and more in electrical equipment, lubrication, paints—wherever heat and moisture are natural enemies. They are not cheap, to be sure, but cost is secondary, in many uses, to the improved performance, lower maintenance expense, and other benefits accruing from their use. It is not at all unlikely that in future kitchens, to take a familiar example, food which is taken from a refrigerator powered by a silicone-insulated and lubricated motor suspended on silicone rubber will be cooked on a silicone enameled stove.

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ANODIZED MAGNESIUM

*Holds Paint, Resists
Attack Like Aluminum*

THE PROCESS used to apply a colorable or protective layer on aluminum has now been successfully adapted to coating magnesium with a similarly useful surface coating of its own oxide-silicate. The anodic layer formed on the metal can be dyed, acts as an anti-corrosion protective coating, and provides a surface to which paints and enamels will satisfactorily adhere.

Conducted by KEITH HENNEY

Tubing Without Troubles

An Electronic Sleuth Probes From Within Metal Tubing to Ferret Out Hidden Corrosion and Other Defects that Might Cause Serious Accidents and Production Losses. Good Tubing is Not Wasted. Salvagable Tubing is Clearly Recorded by this Speedy, Non-Destructive Testing

By VIN ZELUFF

Associate Editor, *Electronics*

• LOOKING AHEAD •

Development of electronic inspection units for steel tubing. . . Lower operation costs of complex chemical and steam plants. . . Greater assurance of trouble-free passage for ships powered by steam. . . Increased reliability of many tubular structures such as aircraft engine mounts. . . Longer plant operating periods without shut-downs for inspection.

ONE of the most serious problems in oil refineries, chemical plants, steam-power plants, sugar mills, and countless other industrial installations using tubular heat-exchange equipment is the constant threat of failure of the tubing due to internal corrosion. These failures often result in serious accidents, loss of life, and destruction of equipment, and levy a heavy toll of lost production due to forced plant shutdowns.

Heat-exchange equipment consists of hundreds, or thousands, of tubes arranged in parallel and gathered into bundles within a metal container or shell. The petroleum industry alone has thousands of heat exchangers and condensers. Through the tubes of heat exchangers pass all crude oils en route to refining process equipment. These oils are heated in the exchangers by outgoing gases or liquid on the outside of the tubes. The condensing of gasoline from a vapor

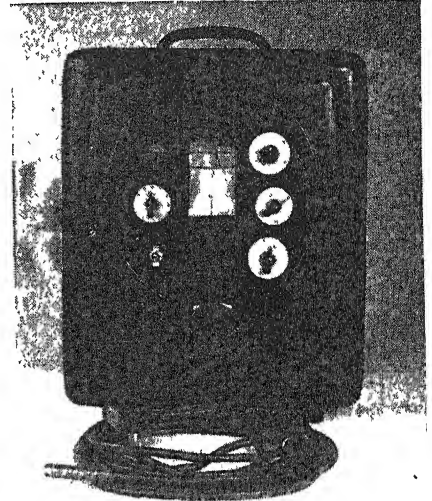
to usable liquid is performed in condensers. Here, the gases pass around tubes which are kept cool on the inside by constantly flowing water.

The chemical industry likewise uses heat exchangers and condensers for either heating or cooling corrosive liquids, vapors, and so on. Steam-power plants have condensers containing as many as 20,000 tubes through which cold water flows to condense steam.

TUBE TESTS—To offset the corrosion problem, engineers have ordinarily provided generous corrosion allowances in the design of heat-exchange equipment, and imposed strict schedules of periodic inspection and test. In the latter, they have used what are admittedly imperfect hit-or-miss methods. An example is the hydrostatic test in which water under pressure is forced into the shell of the exchanger around the tubes, so that tubes which fail completely are detected by water leakage.

Another popular method is that of destructive inspection of random samples, wherein individual tubes from different sections of the exchanger bundle are cut out and split open for visual inspection or examination by chemical, physical, or metallurgical tests.

These conventional methods leave much to be desired. The hydrostatic test shows up only those tubes which are already corroded through, or so nearly through that they cannot withstand a slight extra pressure. Thus it gives no assurance

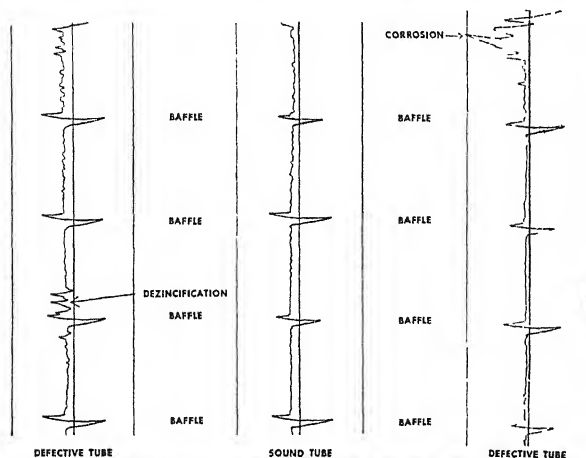


Probolog is compact, easily carried to job. Pen traces permanent record

that the tubes which survive the test without leakage will stand up in service until the next scheduled shutdown, nor even that they will not fail in a few days and cause a serious interruption of plant production.

In the destructive-inspection method, the sample tubes cannot be returned to the exchangers even if they are not split open, since it is usually necessary to cut them out of the tube sheets. In addition, there is no certainty of how representative a sample tube may be, and of just what fraction of the bundle a perfectly good tube may adjoin a row of tubes which are on the verge of failure and, conversely, the detection of a faulty tube might lead to discard of all surrounding tubes even though many of them actually may be in excellent internal condition.

In practice, if either test locates a defective tube, that entire segment of the exchanger may be re-tubed; or if the number of "leakers" appears high it is safest to discard the entire bundle of several hundred tubes rather than risk an emergency shutdown of complex manufacturing operations. Oil refineries have graveyards that are full of discarded heat-exchanger bundles about which the maintenance engi-



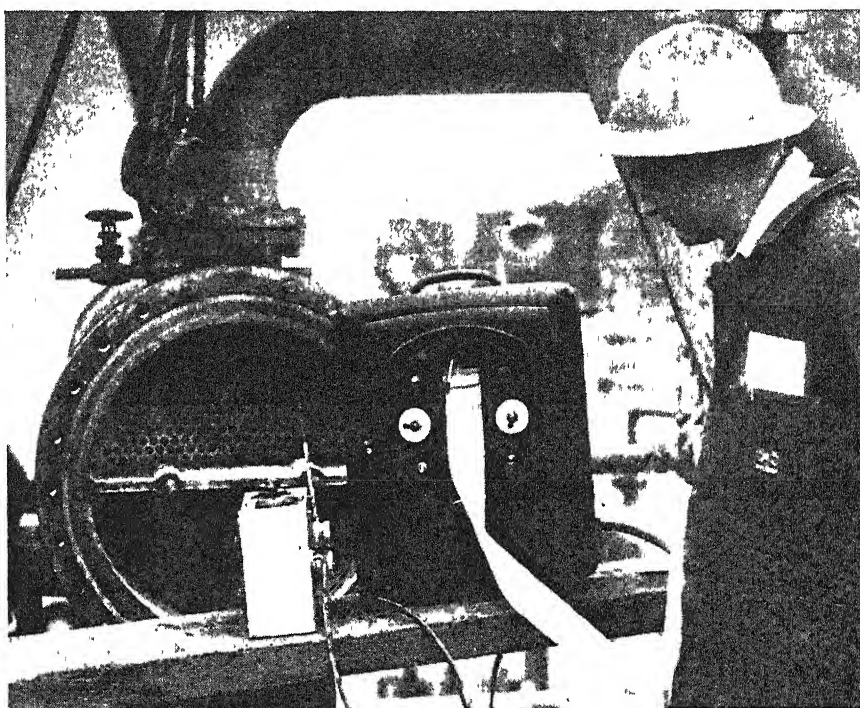
Typical tube records (left) show easily-read trace that spots defective areas and locates such defects relative to baffles. In use (below) probe is pulled through tubes at fixed rate by motor-driven puller device

Courtesy Shell Oil Company

neer often wonders if the right thing was done in consigning what might have been perfectly good and valuable equipment to the scrap-heap.

NON-DESTRUCTIVE TEST—There has been an urgent need for a non-destructive tube-testing method which, by providing a comparative record for each individual tube, would eliminate all the guesswork and place exchanger maintenance on a logical basis. To fill this need, a new electronic instrument has been developed that detects and records quantitatively all types of irregularities in tubes of non-magnetic metals, including such defects as pinholes, cracks, corrosion and erosion pits, variations in wall thickness, and differences in chemical composition. The device is portable, and can be operated by one man at the normal location of the exchanger in the plant. It inspects the tubes from the inside and requires no preparation of the equipment before inspection other than removal of the exchanger head. In use it may be operated either as an indicator or to make a record that can be retained for direct comparison with those of other tubes or with those from other inspections of the same tube at different lengths of service.

The new electronic instrument is called the Probolog, a product of Shell Development Company. In its present commercial form the unit performs routine testing of non-magnetic tubes, and consists of one or more interchangeable probes of different diameters; a mechanical probe puller, usually synchronized with the chart drive of the recorder; and an electronic recorder, equipped with a continuous strip-chart but also incorporating a neon lamp as an indicator. Any defect encountered by the probe upsets the balance of a bridge circuit of which the probe is a part. This is transmitted to the recorder by an electronic



amplifier to make a characteristic record of each defect.

The Probolog may be employed in several ways depending on the particular application and the data sought. For inspection of tube bundles during a routine plant shutdown, for example, one oil refinery uses a standard procedure.

TESTS RECORDED—The instrument is first used as a visual indicator, and a rapid preliminary survey is made of all the tubes. The electronic equipment is adjusted to flash the neon lamp whenever a signal exceeding a specified minimum intensity is transmitted by the probe and the operator explores the tubes as rapidly as he can draw the probe through. Those tubes which are shown by flashes of the lamp to contain defective areas are marked for further inspection, and the remainder passed as satisfactory.

A second inspection of the marked

tubes is then made, using the strip-chart recorder, and the probe puller is synchronized so as to draw the probe through the tube at a standard rate, perhaps 10 feet per minute. A permanent record is thus obtained of the internal condition of each suspected tube. Here, each defect is not only shown graphically but is located along the tube. The record of a faulty tube consists of a series of deflections from a central line—at which the pen is originally set by testing a tube known to be in good condition—and the magnitude of each deflection is proportional to the extent of the particular defect. Relatively little experience is required for proper interpretation of

these records, and an objective basis is thus provided for the retention or rejection of each partially corroded tube.

Metallic baffles and tube sheets appear on the record as defects, causing a wide swing of the pen. Since these deflections are of a large order of magnitude, however, and occur at regular intervals, proper allowance may be made and the record is not obscured.

When records of several tubes are made consecutively on a continuous strip of recorder paper, the wide deflections caused by the terminal tube sheet actually serve to separate the logs of individual tubes. Scale and other non-metallic deposits do no affect the record.

The instrument is designed specifically for the inspection of non-magnetic tubes like copper, brass, Monel, Admiralty metal, copper-nickel, aluminum, magnesium, and austenitic stainless steels. It is unsuitable for

the examination of steel tubes, but a modified instrument adapted to magnetic metals is now under development. An important future use of the instrument is seen in the inspection of new tubes for structural faults. Aluminum tubing, for example, could be tested before construction of an airplane and thus preclude building in basic weaknesses.

TUBE SAVER—The Probolog has repeatedly repaid its cost in terms of savings in heat-exchanger tubes saved from the scrap-heap. The case of an isobutane column condenser recently inspected at the Shell Martinez refinery may be cited as a typical example:

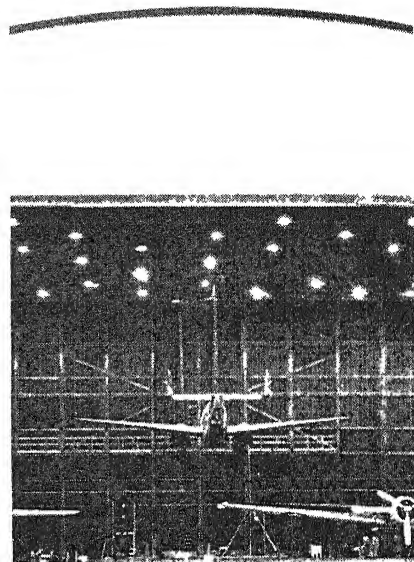
The condenser contained 1224 tubes arranged for two-pass contact of hydrocarbon gases in the tubes against cooling water in the shell. Probolog inspection revealed that 40 tubes in the upper or "hot pass" were defective to the point where replacement was advisable, and that virtually all the 612 tubes in the lower section were in very poor condition. Since the first 40 tubes were scattered throughout the upper bank, it seemed that the entire bundle would have to be scrapped.

The Probolog records showed, however, that the remaining 572 tubes in the "hot pass" might con-

fidently be returned to service and that the corrosion in the lower section was restricted to the first 12 inches of the tubes in from the tube sheet. The result was that not only were 572 tubes of the original bundle retained in place, but 612 additional tubes—shortened from 155 to 120 inches by sawing off the corroded ends—were made available for re-tubing a shorter bundle in another piece of equipment.

The electronic instrument is now in use at Shell refineries in the United States. Training of operators has presented no problem; the average individual usually acquiring facility with the method within the first day. By specifying standard settings of the probe puller and chart drive, tube records are obtained which may be accurately interpreted by any member of the maintenance staff. Files of these records, duly numbered and dated, provide the refineries with a reliable running inventory of their tubular equipment in corrosive service.

A commercial model of the Probolog, embodying all the refinements indicated by practical plant experience over a prolonged period, is now in production. It is expected to find wide application in the many plant installations in which non-magnetic tubing is subjected to corrosive conditions.



Plane suspended in static-test hangar

charged clouds, has at last been almost eliminated from the list of unavoidable menaces to air travel.

Intensive research by a group of scientists at Wold-Chamberlain Airport in Minneapolis showed that this so-called St Elmo's fire, often clearly visible at night on propeller tips, antenna, antenna masts, wing tips, and other projections, can be suppressed by draining off the electrical charge on the airplane. This is accomplished by means of 12-inch long silver-impregnated cotton wicks exposed to the air stream and by using complete polyethylene insulation on the radio antennas and their connections. About a dozen wicks are needed per plane.

TRAMP METAL

Spotted On High-Speed Conveyor Belt by Electronics

DETECTION of metal particles in plastics, food, textiles, rubber, and other materials that pass along a conveyor belt is now possible by a new electronic machine. In operation, a conveyor belt carries the material to be inspected through sensitive coils arranged in a high-frequency circuit developed by RCA. A metal particle hidden in the material creates an impulse voltage in the coils because it distorts their electromagnetic field. This impulse is sufficiently amplified by an electronic unit to operate a warning bell or lamp, stop the conveyor, mark the object, or reject it from the belt. The speed of the conveyor is about 600 feet per minute. Both minute and large particles of ferrous and non-ferrous metals are detected and no specially trained operator is needed.

SHORAN MAPS

Accurate to 10 Feet in 300 Miles, Made Electronically

SLOW and inaccurate methods of surveying land areas by establishing one fixed point after another along a line with rod and chain have been outmoded by Shoran—short-range navigation—another war-time electronic development for which a peace-time use has been found.

In operation, a Shoran-equipped plane sends 20 short-wave radio pulses per second to two ground stations. The stations transmit these signals back to the plane, producing bumps or pips on a thin circular pattern on the cathode-ray screen in front of the operator in the plane. A third pip represents the plane. The operator adjusts the controls until the three pips merge into one, at which instant the exact distances to the ground stations are shown on two dials calibrated in thousandths of a mile. Simultaneously, a camera photographs the dials and another camera photographs the ground vertically be-

low, thus preserving the fix for future use.

Charts and maps can be drawn from a number of these fixes, and older maps can be recalibrated for accuracy. Since each point is located individually, errors do not increase with the number of measurements made, as they do when ground surveys are made along a line. With Shoran, a point may be located within 10 feet at a range up to 300 miles from the ground stations. A geodetic control network of the world is possible, with control stations about every 500 miles.

Initial Shoran surveys are now under way at Buckley Field, Colorado, under the direction of the United States Coast and Geodetic Survey.

ST. ELMO'S FIRE

Long an Aviation Radio Menace, Foiled by Wicks

PRECIPITATION static, the noise caused in aircraft radio receivers by static discharges of millions of volts when the airplane flies through particles of ice, snow, dust, or highly-

Extrusions by Impact

For Certain Products—Particularly Those Requiring Tubular Shapes and Closed Ends—Impact Extrusion in a Fast, Simply Tooled Means of Fabrication. Its Essentials are Only a Punch, Die, and Press—but Its Potentialities Range from Collapsible Tubes to Aircraft Parts

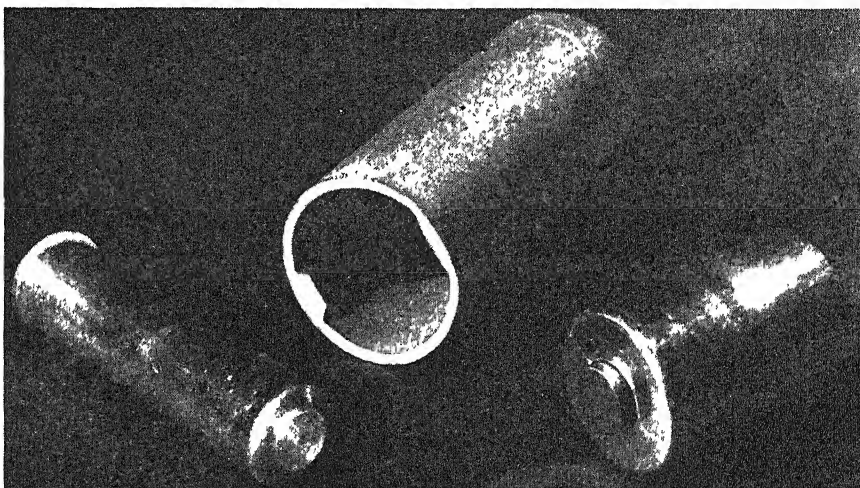
By HERBERT CHASE

AMONG the various methods of producing small metal parts, few have expanded more in recent years than impact extrusion. Once confined largely to the manufacture of collapsible tubes for tooth paste, shaving cream, and like items, impact extrusion is now being increasingly applied to many other types of products, especially those of cylindrical shape with either one end or both ends closed.

Impact extrusions are made by placing metal slugs within a die and striking them with a punch. Thus a part of the metal is extruded through the annular opening between the die and the punch. Such products always have a cupped shape as they come from the die.

Applications include a large variety of cup-shaped parts and tubular elements, many of these being produced as substitutes for, or in competition with, similar parts either drawn from sheet steel or fabricated as die castings, from brazed tubing, and so on. Many extruded parts, however, cannot be duplicated by drawing. This is partly due to the fact that the base of the extrusion is often much thicker—or sometimes thinner—than the walls and frequently incorporates bosses and extensions not feasible to produce by drawing.

In addition to collapsible tubes, which are said to constitute some 95 percent of the total present output of impact extrusions, other products made by this method embrace cases for dry cells; cans for vibrators and condensers, both electrolytic and foil types; transformer and radio-tube shields; cylinders for pumps, door checks, and grease guns; cans for ignition coils; flash-light and cartridge cases; textile sleeves and bobbins; and many other items of cupped or tubular form. At least one aircraft manu-



Accurate forming of walls and ends increases utility of rapid, impact method

facturer has produced flanged and unflanged parts for use as structural elements in aircraft.

As has been indicated, the electrical and electronic industries are the largest consumers of impact extrusions aside from those using collapsible tubes as containers. It appears likely, however, that other uses will be extended as the utility of impact extrusions becomes more generally known.

MANY POSSIBILITIES—The bottom of an extruded cup usually is thicker than the side walls and is, in reality, a forging. Side walls are commonly of uniform thickness, but can have longitudinal beads, can be fluted either internally or externally, and can have a length many times the diameter of the base.

In one type of impact extrusion, the base includes a flange which can have a diameter two or more times that of the extruded portion. In others, a flange is produced by a secondary heading or upsetting operation.

Many secondary operations are performed on impact extrusions.

• LOOKING AHEAD •

Increasing competition between impact-extrusions and drawn sheet metal parts. . . Greater appreciation of the utility of the process. . . Expanded use of copper, magnesium, and silver extrusions as techniques are developed. . . Application to many cup-shaped forms now made by die casting.

They are usually trimmed at the outer end of the extruded portion and sometimes a projection on the base requires trimming to length. In certain forms the base is cut off, leaving only the extruded tube. The base can be pierced, drilled, tapped, threaded, or otherwise machined. Beads are often rolled in side walls and the walls can be pierced, notched, slotted, serrated, given a stepped diameter, spun over, or machined in other ways.

SOFT METALS BEST—Only soft and ductile metals are suited for impact extrusions, largely because the pres-

tures required for harder and less ductile materials become prohibitive. At present the materials used, in order of commercial importance, include lead, aluminum, zinc, and tin. Copper, magnesium, and silver are among other soft metals that can be impact extruded, but as yet the demand for these is slight.

In general, metals that are substantially pure are most readily extruded and—with the exception of lead and zinc metals which are used as nearly pure as can be economically produced—are used for most extruded products. Although pure lead can be extruded readily, the resulting product, especially when it has very thin walls, is too soft to be handled without distortion. For this reason, lead for extrusion is commonly alloyed with about 3 percent of antimony to give the product adequate stiffness. When antimony has been scarce, other stiffening metals—including 0.5 percent silver—have been used in its place.

Although lead has high resistance to some types of corrosion, it is not immune to chemical attack by certain materials for which lead-alloy tubes serve as containers. For this reason, the tubes are commonly lacquered, given some other protective finish, or are tin-clad.

Tin is readily extruded and before

the war was used in pure form for the manufacture of collapsible tubes despite its rather high cost. Tin has a brighter color than lead, is quite resistant to tarnishing, and is highly resistant to corrosion. All these are desirable qualities in collapsible tubes. Pure tin, however, though much stiffer than lead is not stiff enough for some extruded tubes and has often been alloyed with 0.5 to 1.0 percent copper or with small amounts of zinc or bismuth to increase stiffness.

Shortages of tin during and since the war have restricted its use in pure or tin-rich alloys to only a few extrusion applications, chiefly for small containers for drugs or medicinals that cannot be packed safely in other containers. Tin is permitted, however, for cladding of lead for making extrusion slugs for some purposes, provided that the total tin does not exceed 3 percent of the slug's weight. About 95 percent of all collapsible tubes are now made either from lead-antimony alloy or from this alloy in tin-clad form. The remaining 5 percent are nearly all extruded from pure aluminum slugs.

Although lead and tin extrusions serve well for collapsible tubes, they lack the strength, hardness, and stiffness required for most impact

extrusions classed as "shells"—not to be confused with shells such as are used for ammunition. For this and other reasons, either aluminum or zinc, in pure or alloyed form, serve for making most impact-extruded shells and open end tubes—the latter being shells from which the closed end has been cut.

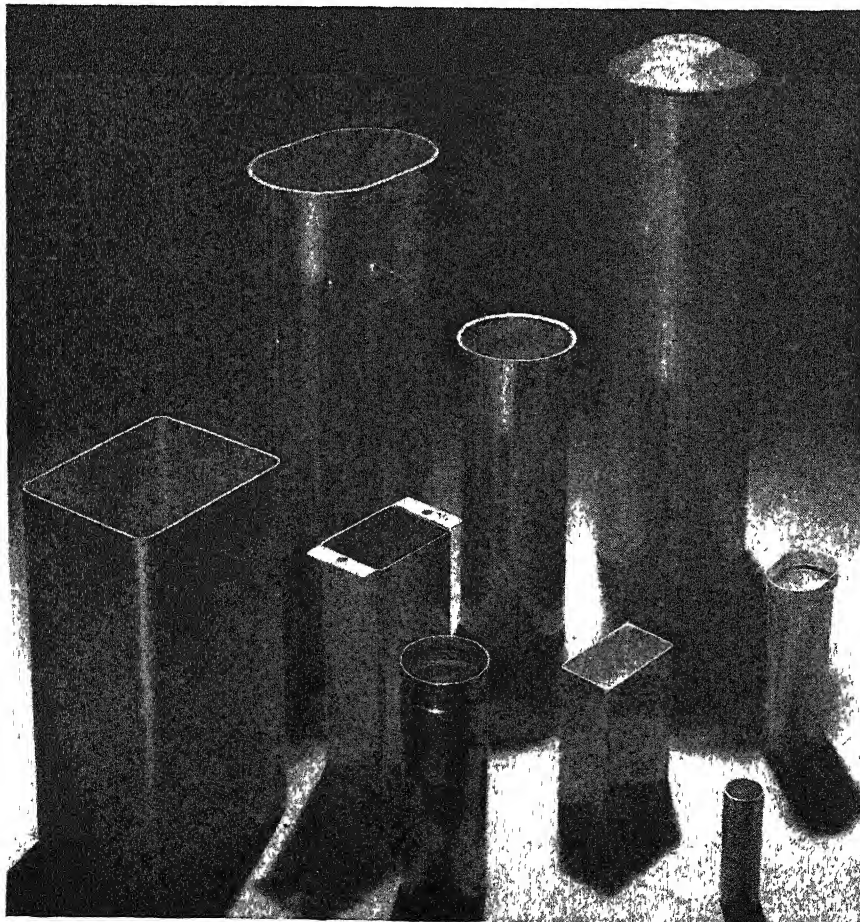
Where low weight or some other special property of aluminum or of its alloys are not essential requirements, either zinc or aluminum may be chosen. Under current market conditions, costs per extruded piece are about on a par. Aluminum and its alloys have some advantage in initial appearance and sometimes in strength over the zinc extrusion, but are not so easily soldered or plated. Zinc is required, of course, for dry-cell cases and, although these are frequently drawn, some shapes for such cells are extruded.

Considerable impact extruding of pure copper has been done. Among the products that have been made are short, open tubes for honeycomb, automobile radiator cores but less expensive types of cores have largely, if not fully, supplanted this type. Other impact extrusions of copper are still of minor importance.

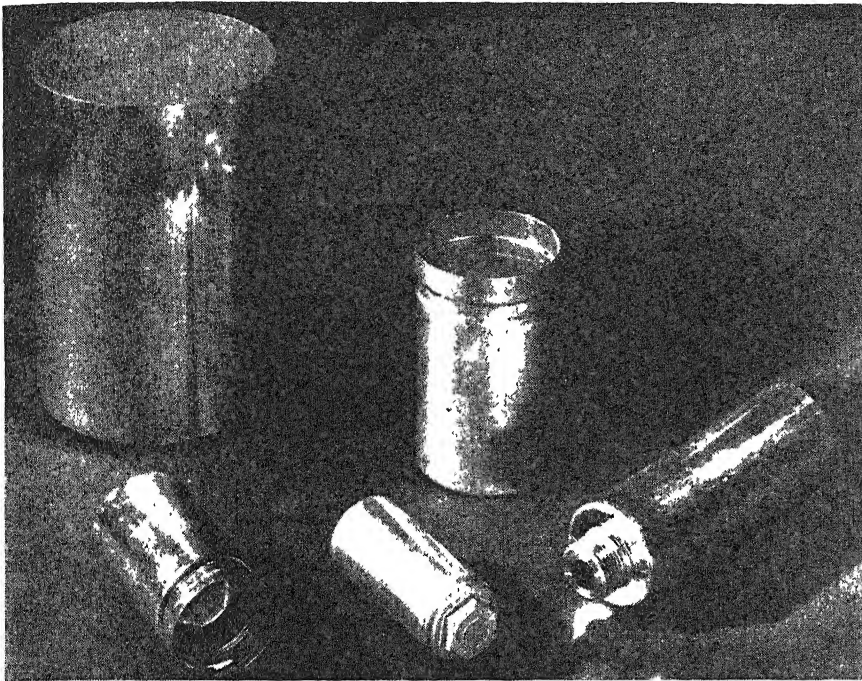
SIMPLE TOOLING—For rapidity and economy in production, crank-type or equivalent positive-mechanical—as opposed to hydraulic—presses are used for impact extruding. As the pressures required are high, the presses have heavy frames and flywheels. For some aluminum extrusions, pressures approaching 200,000 pounds per square inch are said to have been attained. Less pressure is required for softer and more ductile metals. The required pressure is influenced by the shape of the punch and die, and by the thickness of the extruded wall.

All production of impact extrusions requires a die and a punch. In general, the die block and punch holder are more or less standard items. All that is required for making most ordinary extrusions, beyond the standard elements, are a die ring and a punch tip, each being made to fit its respective holder. If special bosses—either interior or exterior—are required on the base of the extrusion, the punch tip, or die, or both must have corresponding recesses.

In the usual procedure, the slug to be extruded is blanked in a press to make a reasonably close fit in the die. In most cases, the slugs are circular, and the parts to be made from them have circular sections. This greatly simplifies manufacture of punch and die parts and makes them quite moderate in cost.



Parts for electronic and radio equipment are well-adapted for impact extrusion



Impact extrusion affords a great variety of closed, formed, or machinable ends

The punch is always smaller than the hole in the die; the resulting space between the die and the punch provides the opening through which most of the metal in the slug is extruded to form the side walls of the product. As the punch is forced into the metal, the latter "squirts"—usually upward—around the punch, thus forming the wall in a small fraction of a second even though it may be several inches in length.

Ordinarily, the slug is made to fit the die fairly closely; the impact of the punch forces the metal to fill all die recesses completely, including any holes for bosses or extensions, before the extruded wall is formed. As the operating cycle proceeds, there is a further flow of metal between the die and the punch to complete the part. As the punch approaches the end of its stroke, it may come fairly close to the bottom of the die recess but usually not closer than 0.030 inch. At that point friction between die and punch end becomes excessive and the punch is stopped. Proper shaping of the die and punch end help to reduce the friction and to lower the maximum pressure required.

RAPID PRODUCTION — Although the production speed on extrusions up to about 1½ inches in diameter varies from about 35 to nearly 70 pieces per minute, the average is close to 60 per minute or one per second. Of this second of time, only about 20 percent is for forming the extrusion itself, even when an extrusion to seven inches long is made. This is considered about the maximum rate of flow economically

feasible in impact-extrusion work.

The length of impact extrusions is limited only by the length of the punch that can be used and the available pressures, extrusions longer than 18 inches have been made and length tolerances can be held to within 0.015 inch. Some aluminum extrusions having an outside diameter of five inches have been made, although zinc extrusions are usually smaller than 1½ inches outside diameter.

The advantages of impact extrusions that appeal to many designers include rapidity of production, availability in forms that are made, ready for use, in a single fast operation, except for trimming; low scrap losses, highly smooth surfaces; one-piece seamless fabrication; unusually low tooling cost; accuracy of dimensions; and close reproducibility from piece to piece.

The limitations are restriction to tubular shapes, with or without a bottom; limited range of materials suitable for the process; specialized techniques; and the necessity for using as raw material slugs which have been previously cut from relatively expensive sheet, strip, and bar stock.

Aside from collapsible tubes, impact extrusions seem to be establishing a special area of use for parts whose length is 1½ to 2 times their diameter, and particularly when the bottom must be thicker than the walls. When the design calls for ribs or bosses in the bottom or sides, or for other special features that cannot be drawn from sheet stock, impact extrusion often is indicated as the best production method.

Exceedingly keen competition exists between drawn sheet metal and impact extrusions for such non-ferrous metal products as dry-cell cases and radio condenser cans. On the other hand, for the collapsible tubes that constitute most of the present market, impact extrusions cannot be duplicated with comparable economy, if at all, by any other method of manufacture.



STEEL-ALUMINUM RIVET

*Heat-Treatable to
Handle High Shear Loads*

DEVELOPED in the aircraft industry to overcome previous limitations on the strength of riveted joints, heat-treatable, alloy-steel rivets are equipped with aluminum alloy collars. The alloy-steel, load-carrying part of the rivet may be heat treated to high strengths, while the aluminum collar permits deformation for heading without altering the body strength of the rivet.

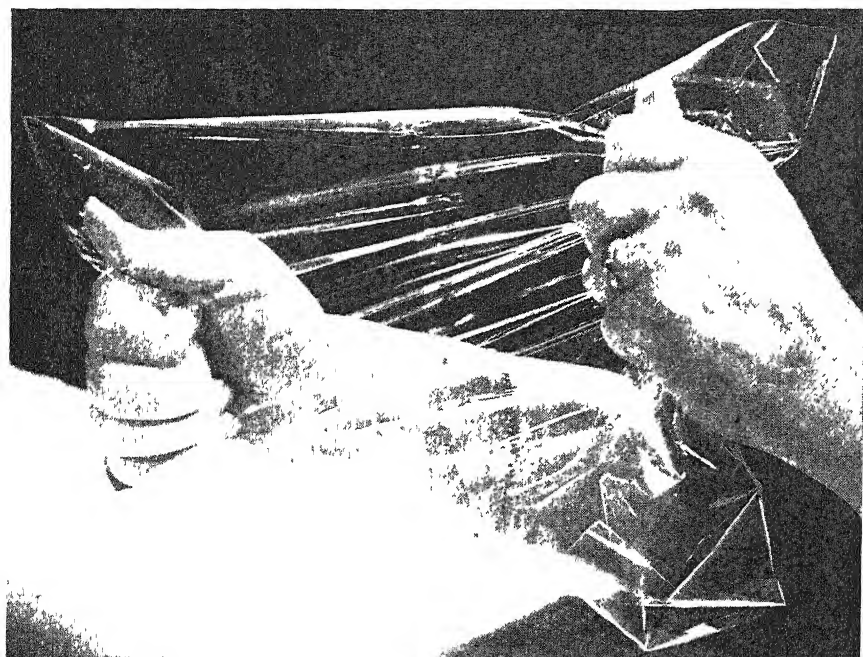
This type of rivet is designed primarily for resistance to shear, shear strengths of 75,000 pounds per square inch being available after heat treating. The rivet was developed by engineers of North American Aviation Inc. and is now being produced by four licensed manufacturers—Pheoll Manufacturing Company, National Screw and Manufacturing Company, American Screw Company, and Fibre and Metal Products Company.

Its success in meeting the need for a fastening of high strength and low weight for critical locations in airframes led to its adoption by most airplane producers for engine mounts, wing spars, stabilizers, firewalls, and so on. It is now going into commercial planes, automobile truck trailers, and other civilian items.

PLATED PISTON RINGS

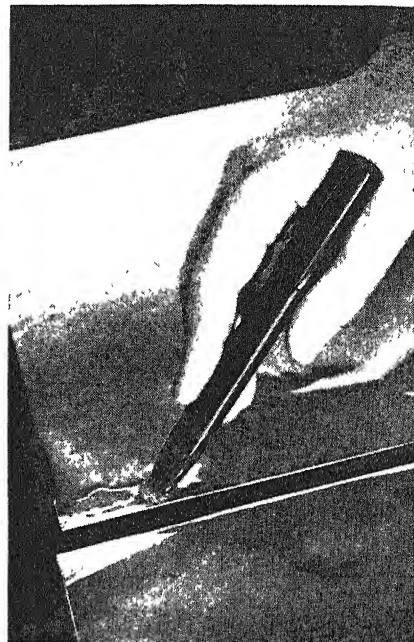
*Show Longer Wear,
Better Oil Retention*

APPPLICATION of the van der Horst porous-chromium plating process to cast-iron piston rings for aircraft, truck, bus, and automotive engines is said to have increased piston-ring life about five times and reduced cylinder wear 30 to 50 percent. Only the top ring of each piston is plated, and the plating thickness is 0.004 to 0.006 inch on the cylinder-contacting surface. The chromium-plated rings are much harder and more wear resistant than unplated rings and the porosity of the plate provides an oil-retaining surface.



Welding of thin-gage acetate sheet is accomplished by applying solvent with pen applicator (below), then quickly placing other sheet on wet area. When set, joint is clear and strong (left)

Courtesy Celanese Plastics Corporation



PLASTICS

Plastics Stick Together

Joining Two or More Pieces of Plastics Together is Something Beyond a Gluing Job and It Just Misses Being Welding. Consequently, Many of the Methods Used are Not Universally Known. With Proper Techniques for the Plastics Involved, Strong, Clear Joints are the Rule

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

EXAMINATION of almost any article made of thermoplastic materials—acrylics, cellulose acetate, cellulose acetate butyrate, polystyrene, and cellulose propionate—discloses that it has either been formed or sawed. And, in a high proportion of parts, the pieces thus fabricated have been cemented together to make the finished piece.

Even more than the forming, bending, sawing, and other cutting operations, the cementing job spells the success or failure of an article. While a slightly uneven edge on a product may mar its appearance, the article can be used as long as the cemented joints are sound.

The cementing of thermoplastics depends on the intermingling of the

two surfaces of the joint so that there is cohesion similar to that in the material itself. With care and practice it is possible to obtain with two pieces of acrylic, for example, a cemented joint that closely approximates in transparency a solid block of this plastics.

This intermingling of the surfaces is entirely different from wood gluing which depends on the adhesion of the glue to each of the two surfaces being bonded. To effect cohesion between pieces of thermoplastic material an organic liquid solvent is used which actually attacks the plastics, forming a well-defined, soft, surface layer called a "cushion." Actually the term "welding" is more descriptive of the proc-

• LOOKING AHEAD •

Better looking, longer lasting plastics products when joining is better understood. . . Designs conceived with a closer attention to assembly problems. . . Lower production costs with faster assembly rates. . . Fewer consumer complaints about plastics articles "coming apart."

ess than the term "cementing," and the term "solvent" more descriptive than "cement," though the latter is the word most commonly used to describe the material making the weld.

To achieve the best bond, the acrylics must be handled differently from the other thermoplastic materials. And polystyrene, while handled in the same way as the cellulose, should employ a different solvent.

SOLVENTS—While both the technique and the solvent are important in cementing thermoplastics, the

selection of the solvent comes first. Highly recommended for use with acrylics is a mixture of equal parts of monomeric methyl methacrylate—inhibited with 0.006 percent hydroquinone—and methylene dichloride. Immediately before using this solvent, a small capsule of benzoyl peroxide is added as a catalyst in the proportion of one capsule to one pint of solvent mixture. Since the catalyst acts to thicken the solvent unless the mixture is refrigerated, the best procedure is to make up only enough solvent for about a half day's work. The mixture also tends to lose a portion of the methylene dichloride through evaporation.

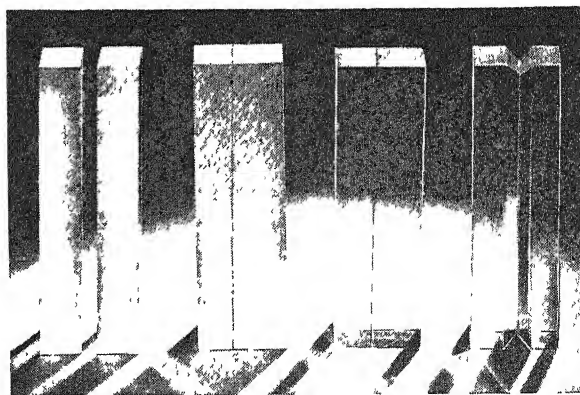
Certain types of work may require the use of a more active solvent than the 50-50 mixture just described. There are small parts that will not be expected to withstand heavy stresses and there are circumstances when for economic reasons production must be speeded. In such cases, the liquid methylene dichloride may be used without any other components. But there is the danger that the joint may show blushing or whitening at the point of weld.

Further down the list of recommended solvents for the bonding of acrylics is glacial acetic acid which must be handled with great care since it is very corrosive and irritating to skin and eyes. At the bottom of the list of solvents is acetone.

BONDING TECHNIQUES—With the solvent decided upon, the next step is to determine the most effective method of using the mix. Most of the work on larger acrylic pieces is accomplished through the use of the soak method which consists of dipping one of the two pieces to be welded in the solvent and holding it there until a softened cushion is formed on the surface to be welded. When the piece is removed from the solution the surface of the cushion is wet with solvent. As this surface is pressed against the dry sur-

Four steps in cementing thermoplastics—left to right mating surfaces are formed, cemented, polished and finally grooved, if practical, to conceal joint

Courtesy Plasteck Manufacturing Company



face of the other part being welded, the excess solvent forms a second cushion on this matching edge, shallow but enough to permit the intermingling of the two surfaces.

Sometimes clear acrylic shavings are dissolved in the solvent to give it a consistency which allows it to be applied like glue. This thickened solvent may be applied with a brush or other mechanical means, but it works on the same principle as the mix used for the soak method, the viscous material acting only as a carrier for the solvent.

The time that a piece of acrylic is left to soak in the solvent varies, but a good average is 15 minutes. The critical period is that between the time the piece is taken from the soak tank and the moment it is joined to the second piece. Since it is the liquid solvent on the surface of the cushion and not the cushion itself that effects the bonding, the joint must be made before the liquid has a chance to evaporate. Otherwise a poor bond results and, if the joint does not break open, it still has poor strength qualities.

Another important time element in the bonding of acrylics is the interval between the time the two pieces are placed in contact and the time actual bonding pressure is applied. This is the period when the liquid surface of the cushion is being absorbed by the opposing dry surface. Naturally this is not done instantaneously, a satisfactory in-

terval ranges from 15 to 30 seconds.

The acrylic pieces must never be immersed in the soak bath unless all surfaces that come in contact with the solvent but are not being bonded have been covered with a pressure-sensitive adhesive. This taping confines the action of the solvent to the area of the joint. It is important for the covering to be well applied and that there is enough overlapping of the tape to prevent the cement from seeping under the edges. If this is not done the surface of the acrylic not being bonded will be marred.

JIGS AND EDGES—Besides the solvent used and the time elements there are a number of other factors effecting satisfactory bonding of acrylic materials. For one thing, the two parts must be joined with great accuracy. In butt joints, for example, both edges must be made true and square before the welding operation begins. Where possible, an effort should be made to design the article so the joining edges are flat. If a curvature is unavoidable, both curves should have the same radius if the pieces are to be butt joined. If an overlap joint is called for, the radii of the two curved parts should be different enough so the two areas mate perfectly.

Sometimes the construction of the article is such, whether the edges to be joined are flat or curved, that jigs must be used to hold the parts firmly together until the weld is hardened. The jigs should be so designed that they apply enough pressure to squeeze all air bubbles from the joint, thus assuring a thorough intermingling, and apply the pressure uniformly. They must also be built to compensate for the shrinkage which always takes place during the hardening of the solvent, for only in this way will the pressure on the bonded joints be held uniform. If the two pieces of acrylic are held rigidly in the jig so that they cannot move together while the joint is drying, the bead of excess cushion will tend to draw back into



Welding halves of plastics barrel-bank. Felt pad is partially immersed in acetone; operator transfers small amount of acetone from pad to edges to be joined together

Courtesy Elmer E. Mills Corporation

the joint, leaving dimples along the outside surfaces. In some cases, bubbles may even be visible. The parts being joined should be allowed to stand in the μ g for at least four hours, and an additional period of four to five hours should elapse before the joint is subjected to handling.

To make a stronger joint, the temperatures can be raised slightly while the acrylic pieces are held together. This will cause the cushion to enlarge slightly. Upon cooling, the size of the cushion will remain constant and will be harder since some of the solvent will have evaporated from the joint. This operation must, however, be undertaken with caution for if the cushion becomes too large or deep serious weakening of the plastics section results.

CELLULOSICS—When the bonding of such thermoplastics as cellulose acetate, cellulose acetate butyrate, cellulose propionate, and polystyrene is undertaken, all the technique learned regarding the acrylics must be discarded. The soaking process should never be used with cellulose because of the quicker action of the solvents on these plastics. Even thorough taping will not protect the surfaces, the action of the solvent through the exposed edges quickly ruining the appearance over a wide area.

Acetone is one of the most commonly used solvents for the cellulose esters. If it is used alone, however, the cemented pieces often take on a white, frosted appearance due to the high evaporation rate of the acetone. So rapidly does it evaporate that it may not even have time to soften the surfaces and effect adhesion. These difficulties can be overcome by the addition of one or more solvents of higher boiling point—methyl Cellosolve acetate, for example. This addition, however, increases the drying time of the weld.

Rather than using either acetone or methyl Cellosolve acetate, it is sometimes found advantageous, particularly on jobs where the surfaces are not smooth, to use a more viscous solvent. For cellulose acetate, such a solvent or dope can be made up with 10 parts cellulose acetate, 60 parts acetone, and 30 parts of ethyl lactate—all parts by weight. The formula for cellulose acetate butyrate is 10 parts of butyrate, 60 parts of acetone, and 30 parts of methyl Cellosolve acetate.

When cellulose acetate is being bonded with cellulose acetate butyrate a suitable cement may contain 75 parts cellulose nitrate of medium viscosity, 25 parts of camphor—nitrate film scrap can be used in

place of the first two ingredients—400 parts acetone, and 200 parts ethyl lactate. For cellulose propionate a satisfactory body cement can be made with 10 parts of cellulose propionate, 60 parts acetone, and 30 parts methyl Cellosolve acetate.

Polystyrene is yet a different matter, benzol being the most desirable solvent for the welding of this plastics. During the war, however, when benzol was difficult to obtain, xylol was used instead. Since with both of these solvents a more viscous solution is the best, granules or shavings of polystyrene may be added until the proper mix is obtained. A good rule of thumb is a 50-50 mixture by weight. It should be borne in mind that both benzol and xylol are very toxic, hence the area where they are used should be well ventilated.

METHODS IMPORTANT—There are a number of methods of applying the solvent to the cellulose and polystyrene. One way is with a brush, care being taken that the solvent is painted only on the bond surface. An even more widely used procedure is that of dipping.

In the dip method the solvent is placed in a suitably shaped con-

tainer. A felt pad is placed in this pan so that its top surface is just level with the surface of the solvent. Then a fine wire screen is placed over the top of the pad. The felt pad acts as a wick, allowing light contact of solvent with the part to be welded and the screen acts to prevent contamination.

With the equipment ready, the surface of the parts to be bonded are brought in contact with the screen and are left in this position until the material has softened substantially. Then the pieces are clamped together and held until the bond is set. This may be done by hand if the parts are small since the joint takes but a few seconds to set. Ordinarily after the joint has set there is a protuberance of material at the weld line. This must be removed by mechanical means but not until the pieces have been allowed to set for from 24 to 48 hours to permit the solvent to evaporate.

Properly done, a cemented joint should cause no trouble and be almost invisible to the eye. What failures there have been have occurred due to lack of knowledge of the "know-how" of cementing—an unfamiliarity of both the solvents that should be used and the methods of using them.

PLASTICS RE-DESIGN

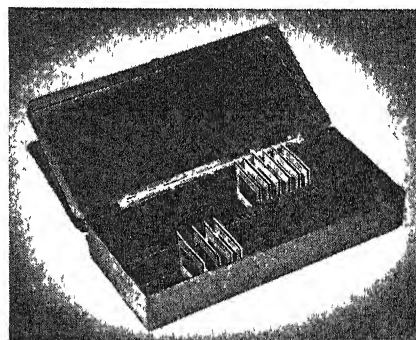
*Proves Need for "Engineering"
On "Non-Plastics" Parts*

IN ADDITION to the new plastics products now appearing on the market, a number of old articles are coming back with new and improved component part. An example is a 35-millimeter Kodachrome slide box molded of Bakelite material.

The original slide box was designed to be assembled by means of a standard hinge having a spring clip in its center. The hinges were first put into molded slots in the side of the bottom half of the box. This, however, made a poor assembly. The fault lay principally in the weight of the cover which was too great for the type of hinge being used. Consequently, when the cover opened up, the snap of the spring plus the weight of the cover frequently pulled the hinge out of the bottom half of the box.

Manhattan Screw Company, in redesigning the slide box, decided that piano-type hinges with no spring would be the best choice for this particular application. This hinge is attached to the two halves of the box with drive screws and thus far has proved successful.

There are many other examples



Hinge, not plastics, needed re-design

of this type of redesign work, particularly in products that combine plastics with other materials. Surprisingly enough, it is often the "other material" that is altered.

DUST PAN

*Low-Pressure Laminated,
Does Not Warp at Edge*

OF INTEREST to manufacturers of household appliances, retailers, and housewives is an experimental dust pan produced from Fiberglas impregnated with Bakelite polyester resins. Turned out by the low-pressure laminating technique, this dust pan thus far shows no tendency to warp or become distorted along the leading edge.

Wax Against Water

Capable of Satisfying the Demanding Packaging Requirements of War, Plus Previously Unposed Problems of Protecting such Things as Frozen Foods, are the Waxes and Waxed Papers. Water Doesn't Penetrate Wax and Modern Waxes are Tough—Hence Give Efficient Protection

By JOHN C. DEAN

Technical Division, Process Products
Socony-Vacuum Oil Company, Inc.

NATURAL waxes of animal and vegetable origin have been employed for centuries in the manufacture and decorating of a variety of articles. Eventually, craftsmen found that these natural waxes could be employed for water-proofing as well as decoration. Natural waxes, however, were not replaced until 60 or 70 years ago when it was found that paraffin, one of the constituents of petroleum, was of a waxy nature.

Paraffin-type waxes, mainly fully-refined waxes, are desirable as coating materials due chiefly to their hard, dry texture. For many applications, however, they are unsuitable because of their brittleness and of limitations in melting point. The

former adverse characteristics is most pronounced at low temperatures, or where rough handling is encountered.

Microcrystalline waxes owe their usefulness to their flexibility and their highest melting point. The drawback to their use alone is tackiness at ordinary temperatures.

It is evident, however, that the advantages of one type may be used to counteract the disadvantages of the other, hence the usefulness of a blend. Usually blends are prepared containing up to 50 or 60 percent of microcrystalline wax, but the exact formula depends on the properties desired to meet service conditions. Increased quantities of microcrystalline wax raise melting point and improve flexibility, but

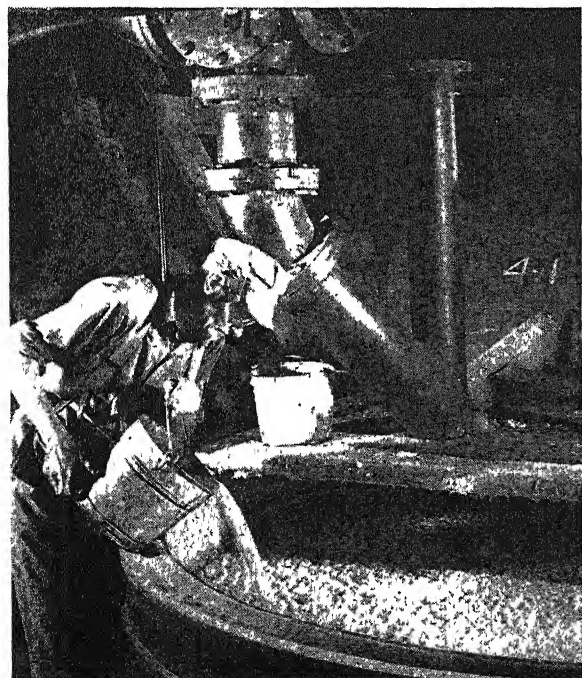
• LOOKING AHEAD •

More ready-to-eat foods in light, easy-to-open, waxed paper packages. . . Fewer instances of water damage when the microcrystalline waxes are used. . . Extensive shipment of tools and precision parts in moisture-vapor-grease-proof wrappings. . . Further progress in substituting wax for lacquer container-wall coatings.

above 25 percent also increase tackiness and the tendency to block or stick together.

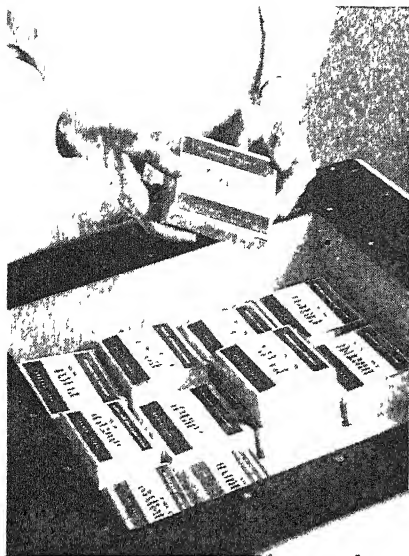
WATER-TIGHT PAPERS—Approximately 80 percent of the production of petroleum waxes is used for the treatment of paper. The value of this treatment is that it provides paper with waxy coatings or impregnations which resist the passage of water or water vapor. Paper consists of countless cellulose fibers felted together and bonded with an adhesive such as resin and alum. As a result, there is a continuous contact of cellulose to cellulose throughout the paper sheet with minute openings between the individual fibers. When water passes through a sheet of paper, it does so largely through these openings rather than along or through the fibers themselves. Therefore, a paper can be made water-tight by filling these openings with a material which is impervious to water.

Water vapor, on the other hand, can be transmitted by cellulose fibers as well as through the openings between them. In order to render a sheet of paper resistant to the passage of water vapor, it is necessary to provide a continuous film of a vapor-impervious material which completely covers the cellulose fibers of the sheet as well as those which protrude above its surface. If the surface fibers or "fuzz" are not coated they can serve as wicks to absorb moisture from a humid atmosphere on one side of the paper and carry it along a chain of cellulose fibers to the other side where



Wax treatment of paper is often done after the paper is manufactured. Here, however, a wax-emulsion sizing is added to pulp in beater to impart water resistance to, and lay surface fuzz of, finished paper

Adapted by permission from "Petroleum Refiner"



Microcrystalline waxes stay flexible at low temperatures, do not chip or flake in packaging of frozen foods

it can be given off to a less humid atmosphere.

These fundamentals are responsible for the fact that three basic types of wax-treated paper are made today. These papers may be classed as wet-waxed paper, dry-waxed paper, and laminated paper.

HEAVY WAX FILMS—Wet-waxed papers are those which have continuous wax films on their surfaces. They are manufactured by applying a heavy film of wax, and immediately setting this film on the surface. Absorption into the paper is prevented either by passing the waxed sheet through a bath of cold water, or by chilling it with a cold roll. These papers may contain as much wax as hase paper stock.

The most important characteristic of a wet-waxed paper is that it possesses a truly continuous coating of wax. This film covers the surface paper fibers completely and prevents them from absorbing moisture from the surrounding atmosphere. Such papers are used where moisture-vapor proofness is required.

A great variety of wet-waxed papers is produced by industry. This is because these papers are extremely moisture-vapor proof and therefore have greater utility in all types of packaging. The commonest wet-waxed paper, and the one produced in greatest volume, is bread-wrapping paper. Similar sheets are those used for candy wraps, and in the interior and on the exterior of cracker and cereal boxes. Practically all of these papers have been produced by the cold-water method of chilling and are therefore very lustrous in appearance.

Fully-refined wax is the most commonly used coating for wet-

waxed papers, but in many applications it falls down because of its inherent brittleness. This is particularly pronounced at low temperatures where it becomes fragile, and where the wax film can be broken quite easily. Any break in the wax film exposes paper fibers which are free to absorb water vapor. Microcrystalline waxes are especially useful in overcoming this deficiency of the paraffins, since when they are blended with paraffin wax they impart a portion of their flexibility to the mixture. The increase in ductility is roughly proportional to the quantity of microcrystalline wax used.

There are a number of applications where such an improvement in flexibility of the wax coating is essential. The packaging of frozen foods is probably the one which will be of greatest importance. Foodstuffs so packaged must be handled at temperatures as low as zero degrees, Fahrenheit, and must be continuously protected against loss of moisture. If straight paraffin waxes are used for coating paper or packages for these frozen foods, the wax films on them will be subject to fracture and their protective action will be lost. Blends containing 25 percent of microcrystalline waxes are far superior to straight paraffin waxes for this purpose.

DRY WAXING—When waxed papers are so treated that relatively little wax remains on their surfaces, they are termed "dry-waxed." These sheets are prepared by processes which cause a controlled amount of wax to become impregnated into them, and which eliminate surface wax to a large degree.

The fundamental characteristic of dry-waxed papers is that they do not possess continuous films of wax. Paper fibers which protrude above the surface are not completely coated and so are free to absorb moisture which can be carried through the sheet by the cellulose fibers. Such papers cannot be employed where moisture-vapor proofness is essential. Dry-waxed papers, however, are waterproof for practical purposes, since wax has filled the openings between the fibers through which water would pass.

As with wet-waxed papers, there is also a great variety in the types of dry-waxed papers which are produced today. These papers are employed where there is no requirement for moisture-vapor proofness, and where the only need is for resistance to water. Typical examples are delicatessen papers, drinking cup stock, and water-proof bag papers.

Dry-waxed papers are most commonly made with either fully refined waxes or crude scale waxes. Since the wax in the paper does not exist as a continuous wax film there is little advantage in the use of microcrystalline waxes. Furthermore, the wax is so firmly supported by paper fibers that cracks or breaks in it are not apt to be formed during rough handling or exposure to low temperatures. In most instances, therefore, service conditions are not severe enough to warrant the use of microcrystalline waxes.

GREASE-PROOF PAPERS—The passage of grease through paper is generally through the openings between the paper fibers and is not along the fibers themselves. Obviously the most grease-resistant sheets are those which consist of a continuous film of cellulose such as cellophane or glassine paper, but other papers can approach these grease-resistant sheets if they are impregnated with an oil-resistant substance.

When a sheet is thoroughly impregnated with a slightly oil-soluble material, grease, fat, or oil can pass



Wax between layers of paper laminates acts as adhesive and moisture barrier

through the paper only after it has dissolved enough of the material to develop openings between the fibers. Obviously, therefore, products which are the least soluble in these non-aqueous substances will be most effective for grease-proofing purposes. Microcrystalline waxes are only limitedly soluble in oils, fats, and greases, hence they are useful as grease-proofing agents. The solubilities of petroleum waxes in fats and oils are directly related to their melting points. For example, a wax melting at 133 degrees, Fahrenheit, is only half as soluble as one melting at 125 degrees Fahrenheit. When the melting point is increased to the microcrystalline-wax range the dif-

ference is even more pronounced. A wax melting at 165 degrees, Fahrenheit, has only one twentieth the solubility of one melting at 133 degrees, Fahrenheit. This disproportionate effect of melting point permits a fairly grease-proof paper to be produced with conventional microcrystalline waxes.

PAPERS LAMINATED — Laminated papers consist of two or more layers of paper bonded together with an adhesive. When wax is used as the binder it also serves as a moisture-vapor-proof barrier. These papers are prepared by applying the wax to one of the sheets and combining the second with it by means of press or squeeze rolls under controlled conditions.

Laminated papers are useful because two entirely different sheets may be used simultaneously and advantage taken of the characteristics of each. For example, a moisture-proof and grease-proof boxboard can be produced by laminating glassine paper to chipboard with a microcrystalline wax. The chipboard supplies the structural strength, the wax the moisture-vapor proofness, and the glassine the grease-proofness. Because of their unique construction, laminated papers have many of the advantages of both wet- and dry-waxed papers. A continuous wax barrier is present, as in the case with wet-waxed paper, yet the wax film is protected on each side so that its continuity cannot be destroyed by careless handling or scratching.

The wax employed in laminating plays a dual role. It provides the moisture-proof barrier and also serves as the binder for the layers of paper. Even paraffin waxes would provide a satisfactory barrier, but these waxes do not possess adequate adhesiveness; and as previously stated, they are not sufficiently flexible to maintain a continuous wax film. Microcrystalline waxes are particularly suitable for laminating because they are adhesive substances and because they are plastic and flexible.

Many combinations of paper and laminating agents are possible, but all may be grouped roughly into two basic classifications. The first group is composed almost entirely of transparent or translucent papers such as glassine. These grades are used largely for packaging foodstuffs, particularly where their transparency is needed to permit an inspection of the contents of the packages.

The second group is more diversified and comprises papers made by laminating either glassine or parchment to such sheets as paperboard,

or kraft and sulfite papers. These products are employed in many packages such as coffee bags, doughnut and cracker boxes, paper cans, wrappers for paperboard cartons, and certain meat wraps.

PACKAGING METHODS — Some packages, notably paper milk bottles and containers for some foodstuffs, are waxed prior to filling. This is accomplished by immersing a carton, the bottom of which is usually glued, into a wax bath, allowing it to fill, emptying the wax from it, and permitting it to drain.

More commonly, wax is applied to paper packages after they have been filled and sealed. This method may be used for dry materials, and is preferable for several reasons. Since the package is glued before waxing, it is stronger mechanically. Waxing is generally the last operation, and handling of the waxed package is held to a minimum, thus reducing the possibility of marring the wax film. Finally, this type of package does not depend upon a separate sealing operation to insure a continuous wax film.

Two basic methods of applying the wax are in common use. One is by passing the carton under a shower of molten wax, and the other is by dipping the carton in to a wax bath. The shower method is generally more complicated, and has the disadvantage of aerating the wax, which is conducive to oxidation.

The dipping method, therefore, is most widely used, but the modifications of it are numerous. Two general means of dipping are employed. In the first, or "complete-dip" method, the entire package is submerged, removed, and allowed to drain and cool. In the second, or "partial-dip" method, only a portion of the package is coated with each immersion. After the first dipping and cooling the package is inverted and the uncoated portion is dipped. This immersion is so controlled that a slight overlap of the two coats is obtained.

FUTURE PACKAGING — The use of wax-treated paper and paperboard as packaging materials will probably continue during the coming years. Many advantages accrue from their use, including lighter weights and lower costs.

In addition, containers for shipping liquids are constructed of metal, wood, or glass, and frequently the container walls are subject to attack by their contents and require a protective coating. Lacquers have been used for this purpose, but microcrystalline waxes offer a less expensive and often more effective

means of accomplishing the same result. Thus, metal packages can be adapted for the shipping of materials normally requiring less durable glass containers. Wooden containers can be water-proofed to prevent loss of moisture and to prevent deterioration. Glass and ceramics may be protected from etching. In some cases, such as in shipping hydrofluoric acid, the entire container may be of wax because microcrystalline waxes, composed of hydrocarbons, are chemically inert. Similarly, various metals may be wax coated to prevent attack by the elements.

Thus it may be seen that many factors are at work which will offer even greater opportunity for the waxes as packaging and protective materials. New products requiring new packaging methods, greater knowledge of the abilities of the waxes, wider public acceptance of light, easily-shipped, paper containers, and several years experience in packaging for the most adverse conditions all combine to indicate an ever-growing range of usefulness for wax.

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DETERGENT OILS

*May Cause Damage
In Outboard Boat Engines*

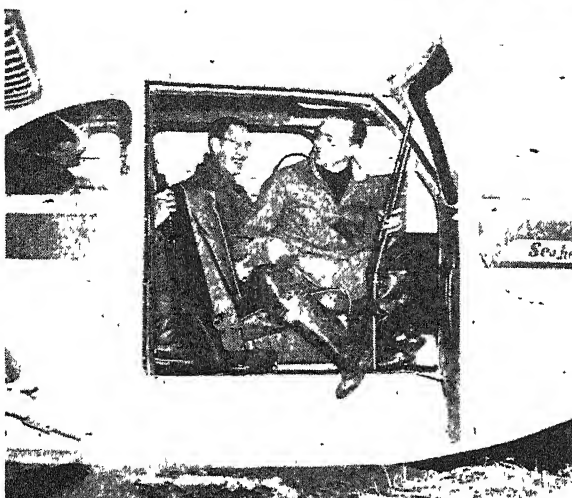
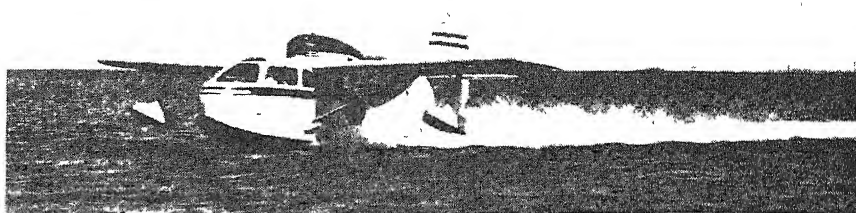
MODERN motor oils containing detergent agents and intended for four-stroke cycle automotive engines are reported by the Outboard Boating Club of America to be causing serious damage to the two-stroke cycle engines commonly used as outboard power. Apparently the difficulty stems from the direct introduction of the fuel-oil mixture into the engine combustion chamber. Here, it is said that the detergent additives form a heavy ash deposit on the piston head and within a short time the deposit engenders pre-ignition.

Once these conditions of excess ash and pre-ignition are established, the restrictive effects seem to accumulate rapidly — ash working past the rings damages pistons and cylinder walls, lubrication is impaired, varnish coatings form on the rods and crankshaft, and eventually the engine "freezes" up.

These actions do not occur in automotive engines where the oil is retained in the crankcase and the detergents are allowed to function as intended.

The solution to the problem is, of course, the selection of an outboard-engine oil that is specifically made for that purpose.

Easy handling on water and rapid take-off (right) make Seabee an ideal plane for sportsmen as exemplified by duck hunters (below). Craft holds four men, guns, folding boat, and other equipment—fuel load is adequate for 560-mile trip



AVIATION

Pressed-Out Planes

Sounding a New Note in The Aviation Industry—Where High Costs are Legend—Is the Republic Seabee Amphibian. Capable of Carrying a Family-Sized Load in Automobile Comfort, This Land-or-Water Airplane Offers Much Utility and Good Performance at a Reasonable Cost

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

• LOOKING AHEAD •

In aviation and elsewhere will come wider adaptation of the "Seabee" formula. . . Simplified design plus pre-production market studies. . . Competition from other planes eventually but a substantial lead now. . . A heightened public standard measured in plane-for-money terms. . . Perhaps a greater appreciation of inherent amphibian advantages.

IN THE Seabee amphibian, a bold and successful attempt has been made to build a personal or family aircraft having wide popular appeal and utility. In doing so, Republic Aviation Corporation engineers solved many problems in structural design, metallurgy, and corrosion protection, and have developed mass-production methods on a limited-production scale. This effort, therefore, has immense interest not only for aviation, but for many other industries faced with analogous problems.

Prior to designing the craft, a definite goal was established. What was wanted was a family plane capable of carrying four persons comfortably at reasonable initial and operating cost. Enough speed

was needed to realize the real value of flight without seeking to emulate a single-seater fighter. Equally important was a plane that could make use of small landing fields, and primary consideration was given to an amphibian because such an aircraft gives a greater range of utility than either a land plane or a seaplane.

The building of a craft having amphibian characteristics, however, meant that both the difficulties of a land plane and the headaches of a flying boat had to be conquered in spite of the fact that they had been multiplied by combination.

DESIGNED FOR UTILITY — The Seabee, as realized, satisfied all the basic requirements. The hull has good water lines and blends into a well-streamlined upper cabin enclosure. There is no break between the lines of the hull and the lines of the superstructure. The well-rounded bow and the sides of the cabin provide excellent vision

through seven large Lucite windows. The engine is mounted above the wing with a pusher propeller so that spray does not touch the propeller blades. Power-plant noises and gas and oil fumes are behind the passengers and reduced to a minimum.

Little spray develops on takeoff and the hull provides pitching stability in the water. Also, to take care of lateral stability, streamlined auxiliary floats are mounted at the tips of the wings.

From the comfort standpoint, the cabin is 110 inches long, 46 inches wide, and 50 inches high—as roomy as most motor cars. Kapok cushions and water-proof washable upholstery are provided. Equipment includes two-way radio; ground adjustable propeller; electric starter; dual-wheel controls with a convenient single instrument panel between the two occupants of the front seats; fully-retractable landing gear and landing flaps, both hydraulically operated; and a fairly complete

instrument board with a ball-bank-indicator.

The airplane's price—\$3995—is important. It is possible to get nearly anything desired in the air, including flight speeds of 600 miles per hour, but only at a price. The problem is to give the public versatile and dependable flying at a reasonable figure. Economical civil aircraft design is far more difficult in some ways than military design where, provided the specification can be met, expense is a minor consideration.

Many buyers, though they may be satisfied with the initial price of an airplane, are somewhat concerned about the costs of operation. These costs will vary with the hours of use per year. Hence they must be estimated along certain general lines. Ordinarily, for example, to storage or hangar charges must be added 20 percent depreciation per year; for all-risk insurance the premium will be between 5 and 8 percent, with an added charge for public liability. Direct flight costs include 13.5 gallons of gas and a quart of oil per hour for the Seabee—far from negligible.

In addition there is an expense of \$1.50 per hour for inspection, maintenance, and overhaul. On a basis of 500 hours of flying per year, the total cost works out to about \$9.00 per hour. This sounds formidable, but actually amounts to only 9 cents per mile because the aircraft flies at 100 miles per hour. Thus, per person, the operating costs figure a little over two cents per mile.

METAL OR WOOD?—In planning the Seabee there was one big question to be answered by the designers—should the hull be of wood or metal? The same question is likely to be asked for other products such as canoes and boats; consequently the answer is of rather general interest

A wooden hull, which really means a hull sheathed in plywood, is a far better product than it used to be because of improvements in adhesives. But plywood hulls still gather barnacles in sea water, and plywood hulls still absorb moisture. Moreover, wooden hulls are likely to splinter in a crash; are liable to disintegration after a few years service, and wood is not as uniform a material as engineers like to have. Finally, wood does not lend itself to rapid-production methods, because wood construction nearly always means the assembly of many small parts.

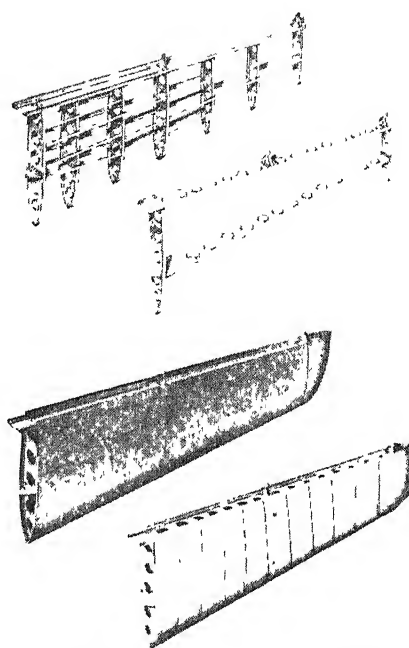
The capacity for aluminum manufacture has vastly increased since the war, its price is going down steadily, and strange as it may seem a knowledge of aluminum repair is more widespread than a knowledge of plywood repair.

The question of hull corrosion, particularly when used in sea water, appears to have been answered by new alloys which serve for exterior protection. These alloys offer to the elements either a pure aluminum surface or one that has been oxidized, both of which are said to be better and stronger than the Alclad previously used.

If the aluminum alloy is anodized, then covered with zinc chromate and painted, it becomes impervious to seawater. Also, the relatively expensive anodizing treatment may be replaced by a lacquer process which is less costly.

Aside from the actual materials used, other precautions were observed; these included elimination of areas that collect moist dirt and provision of drain holes

COST REDUCTION—When the aerodynamic, hydrodynamic, corrosion, and general-design problems had been solved, there still remained the great problem of cost reduction in the air frame. In describing



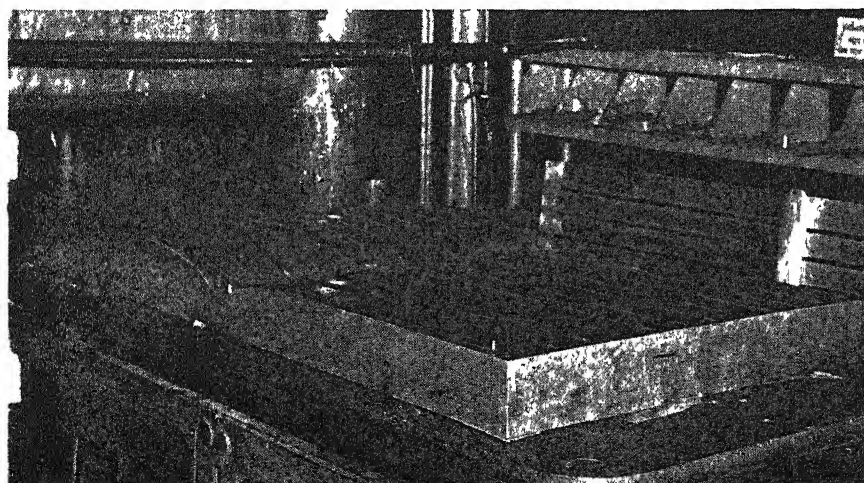
Simplified design is key to Seabee's low cost and production plans. Early, multi-spar tail surface (top) evolved to ribless, two-spar unit. Outer skin was thickened, chord-wise stiffening channels (bottom) are die-pressed in.

planes, manufacturers are apt to stress the great amount of work that has to be done and the many thousands of rivets that have to be put into place. Rivets, however, cost money. Thus the dilemma evolves—costs are high, therefore sales are limited; when sales are limited, costs go still higher.

To meet this problem, as it involved the Seabee, it was decided to build 5000 planes in 1946, with a production of 40 machines a day in August. Next, to reduce costs, the Republic Aviation engineers broke with tradition and adopted new methods of design. From 1800 parts in the conventional air frame the new design was reduced to 450 parts. About 2500 man hours per plane were cut to 200 man hours. Tooling costs were shrunk from an estimated \$1,750,000 to \$400,000.

Most of these reductions stemmed from a new concept of design in which the aluminum skin was thickened and many interior bulkheads and longerons were eliminated. In a conventional stabilizer structure, for example, a multitude of ribs, spars, and stringers are used. In the simplified structure, thickening and beading the outer skin allows simpler construction, requires fewer parts, and obtains a lighter or at least no heavier unit at much lower cost.

PRODUCED ON PRESSES—The concept of a thickened skin, however, was not sufficient. An equally important step was to follow automobile



Camel back, Kirksite die forms skin contours, pressed-in stiffening sections

practice and stamp out huge skin sheets, larger sheets perhaps than ever before stamped out in the aviation industry

At first, temporary tools were used to press the wing skins and hull sides of the Seabee. For the wing, the die is a camel-back type made of Kuksite, which together with a slotted steel matt gives sharp bead impressions. After the die pressing on a 5000-ton hydraulic press with a rubber pad, the skin is folded at the leading edge to remove the camel back. Thus in two production operations, the wing skin is complete with contour, strength, and rigidity. Similar methods are used for the hull.

In the permanent production set-up, male and female steel dies are used on a double-action mechanical press—the hydraulic cycle being too slow—to turn out over 300 skins per hour of aluminum alloy clad externally with pure aluminum. Similar forming tools are used to manufacture the ailerons, flaps, stabilizers, and so on.

From a sales viewpoint, the Seabee apparently has been almost universally well received. There was a total of \$700,000 in sales in nine days during a recent aviation show. Doctors, lawyers, radio artists, business men, and resort and fixed-base operators were among the purchasers.

It seems possible, therefore, that this plane is an overture to a wider realization of the value of limited-mass-production thinking in aviation as well as other industries.

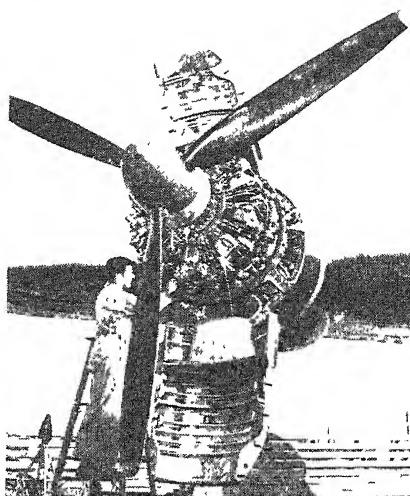
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CONSTELLATION COWLING

*Opens Like Automobile Hood;
Reduces Ground Time*

TWO FEATURES must be present in any airplane designed to maintain high-speed schedules. One, of course, is the ability to fly fast; the other is a design that allows ground servicing to be accomplished in a minimum of time. To achieve the latter, a new cowling arrangement on the Lockheed Constellation allows immediate access to all vital areas of the four 2500-horsepower engines. The cowling, which opens in a manner similar to an automobile hood, makes possible a substantial reduction in ground time.

Standard type cowls usually require about 15 minutes for removal, but it is reported that the new four-panel, hinged type may be opened in about two minutes. Quick-opening, flush-type latches secure the



Maximum accessibility for service in minimum time marks new cowling design

panels which are hinged to the main structures of the engine nacelles. When open, there are no support members to interfere with vision or tools.

LONG-RANGE PLANE

*Has Cargo Handling
Equipment Built-In*

THE GLOBEMASTER, aptly named Army version of the new Douglas DC-7, is a four engine transport with a specified maximum range of 7800 miles. A clean lined, low-wing design with tricycle landing gear, a 173 foot wing-span, and a gross weight of 155,000 pounds, the plane is powered with 3650-horsepower Wasp "Major" engines. Equipped with reversible propellers—either three-blade Hamilton Standards or the four-blade Curtiss models—landing runs as well as tire and brake wear are appreciably reduced and the plane may even be backed into a hangar under its own power. Six fuel tanks, integral with the wing, carry enough fuel at full-range loading to drive a passenger automobile 165,000 miles.

Some of the Globemaster's features, representing the recent advances in aeronautical design, are de-icing through the application of heat, laminar-flow wings; full-span

flaps, and internal wing walkways to permit flight servicing of the powerplants. Cargo handling problems have been given careful attention and a built-in freight elevator and traveling cranes will facilitate handling large or heavy shipments.

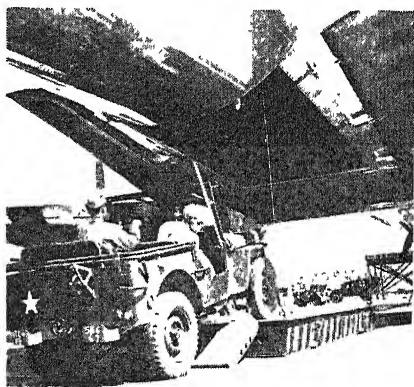
UTILITY GLIDER

*Is Delivered on
"Freight in Tow" Basis*

GLIDER manufacturers, encouraged by the war-time success of towed gliders, are hoping to expand the peace-time market for this type of aircraft. Thus, Schweizer Manufacturing is planning nation-wide distribution of its SGU-19 utility glider—a glider of rugged, dependable construction suitable for training, school use, and general purposes.

The SGU-19, while offered in kit form with explicit assembly instructions, is more frequently sold factory assembled. A novel delivery method is being tried in which the glider is flown to the purchaser by towing it behind a small, 65-horsepower tow plane.

It is reported that the SGU-19 has, on occasion, soared to altitudes of more than 5000 feet and has—although only a utility glider—remained aloft for five hours at a time. The 320-pound glider has a gross weight of 550 pounds and a wing span of over 36 feet.



Heavy cargo is easily loaded (above) by plane's self-contained hoist. Full view of Globemaster (below) indicates large capacity of 155,000-pound craft



Paint For Production

Industrial Buildings and Machinery, Painted in Carefully Chosen and Matched Colors, are Something More than Decorative. Tangible Boosts in Production, Safety Records, and Employee Morale are Usual Results; Bonuses are Cleaner Plants, Lower Upkeep Costs, Better Housekeeping

By J. A. MEACHAM

The Sherwin-Williams Company

A STRONG trend toward informed use of color in industrial plants and offices is now underway. Industry is firmly convinced that through properly selected colors, seeing conditions can be improved, and production output increased accordingly. There is an awareness also of the collateral advantages of improved morale, increased safety, and better housekeeping in the plant.

Actually, the idea of using color in factories is by no means new. Magazine articles published nearly a decade ago promoted the very ideas now being so universally accepted. For example, an article published in *National Safety News* in 1937 read in part:

"Today colors of high reflectivity other than white are being used in modern maintenance work because they not only diffuse light but promote a stimulating atmosphere for the employees. Color pleases people, and its effect on workers in a plant is no less than that which influences shoppers in a store to buy merchandise that is attractively

colored. There is a growing record of improved morale and employee good will in plants where color has been used.

"Machines in light colors are kept cleaner. It has become a growing practice to paint machines and equipment in soft pastel shades that ease the workers' effort to see and reduce eye strain even though the eyes are focused on operations for long periods of time."

Although much progress has been made in the use of industrial color since the foregoing lines were written, they are just as pertinent today and actually represent the foundation on which the color story rests.

INCREASED PRODUCTION — The primary consideration in using color in industry is, of course, increased production. Properly selected colors give better seeing conditions by reducing glare from wall and ceiling surfaces. Lighter colors on the machines themselves give better balance between the brightness of the work and its surroundings. This is essential for sustained critical vision.

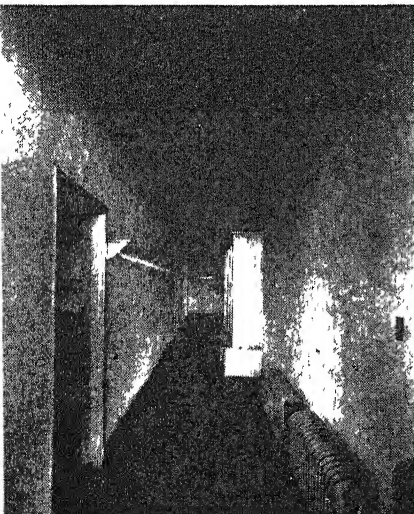
Long study of the psychological factors involved has demonstrated that when the brightness of the task is five times that of the surroundings the ability to see is reduced to 77 percent of normal, and conversely where the surroundings are five times brighter than the task vision is reduced to 44 percent. The optimum condition occurs when both the task and the surroundings are of approximately equal brightness, a balance which can be ob-

• LOOKING AHEAD •

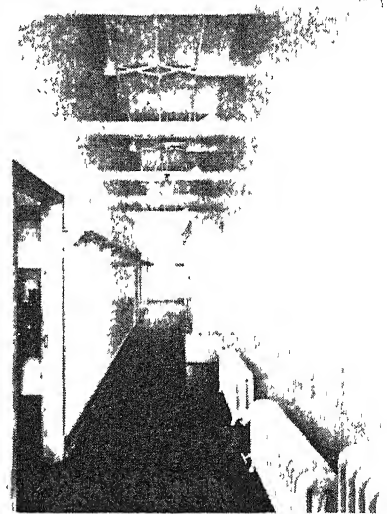
Dark, dingy factories are going out . . . Employees will expect and demand pleasant, colorful, working atmospheres. . . Plant streamlining forces careful planning; will increase storing and handling efficiency. . . Better lighting must accompany color-conscious painting. . . All factors will improve safety, save money above painting costs.

tained through the wise choice of color. At one southern plant that makes pipe fittings, a time study showed that workers output began to fall off about 10:30 in the morning and 3:30 in the afternoon. After the plant had been refinished in color, production did not begin to slump until 11:00 A.M. and 4:00 P.M.

MORALE — Of almost equal importance is the function of color as a morale builder. The factory worker spends most of his waking hours



Contrast of light values in hallway prior to painting (left) and after a coat of well-chosen paint (right) is a typical result of functional color



at his shop. He is entitled to a reasonably pleasant and attractive atmosphere at his place of work. It has been amply demonstrated that employees respond to an occasional change in work or environment. This may take the form of an increase in wage, a new operation to perform, or work in a new department. Repainting walls, ceiling, and machines is one way of supplying this boost in morale.

Exemplifying this factor is a concern with a number of plants in various cities. In one of these cities there were two other companies engaged in the same type of production, all competing for a limited supply of labor. The two competitive concerns were in brand new plants whereas the first company occupied a building designed to meet the requirements of a previous period when employee welfare was not a prime consideration. All these firms paid the same hourly rates, yet the firm with the older building was unable to hold its labor supply. The solution was the creation of an attractive atmosphere in this plant through the use of paint.

NEAT AND SAFE — From the practical angle, experience shows that workers keep a plant cleaner when attractive colors are used on machines, walls, and ceilings. The worker is proud of the improved appearance of his surroundings, and tries to keep them so. Actually, maintenance costs are lowered rather than increased. The factory manager of one manufacturing concern said, after his plant was painted recently: "For the first time in my life I saw a man walk 20 feet to throw a piece of waste cloth in a bin. Individual workers do more of the cleaning in their spare moments. I have watched a lathe operator wipe off his machine with a piece of waste cloth while watching

the cut." When machines are painted in a dull, unattractive gray amid bleak surroundings, there is no incentive to individual housekeeping of this type.

Not the least of the advantages of color is its contribution to safety. One plant reported a decrease of 40 percent in personal injuries after a modern color job was done. Simply through the improvement in illumination, color makes a safer plant. Westinghouse engineers say that their philosophy is to make "every hazard visible." When dangerous parts are identified with attention-compelling colors, when aisle ways are outlined with zone marking lines, when dark passageways and areas are brightened up with light reflecting colors, the safety index of the plant rises noticeably.

COLOR USAGE—Before taking up some of the more recent developments in industrial color harmony a few fundamentals should be reviewed upon which industrial color usage is based. The colors of the spectrum of white light are familiar to all. From deep violet they shift imperceptibly, wavelength by wavelength, to deep red. Essentially, however, industrial painting does not deal with the pure colors of the spectrum, but with softened or grayed tints vastly different in appearance and effect. Only for accent and to demand attention is pure color resorted to, and then in small areas only. This fact, of course, is not new. Not only in the paintings of old masters, but also in the architecture of the past, this knowledge of the proper use of soft color tints is evidenced.

Color is a sensation rather than a property of matter, and perception of the same color may be quite different under different conditions. For example, a piece of blue paper against a black background appears

to be quite another shade when seen against a green background. Gray circles, all identical, appear vastly different in brightness when seen first against a dark background, and then against a light background.

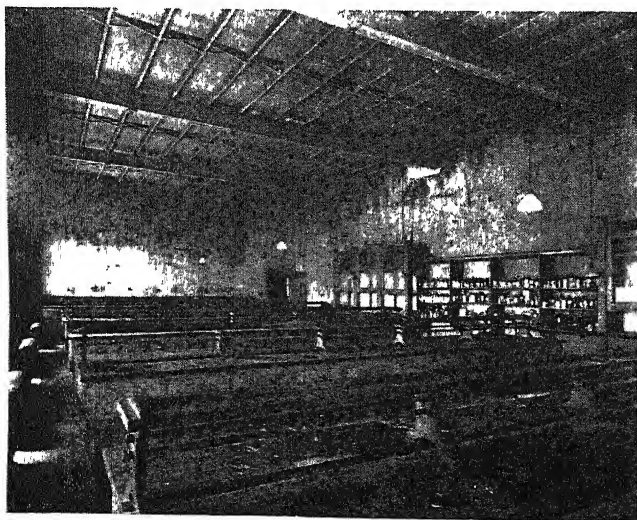
In like manner color effects the perception of other properties, notably size. A white circle appears larger than a black one of the same diameter. A gray circle appears midway in size between the white and the black. Some colors cause objects to stand out. These are called "advancing colors." Other colors push objects into the background. These are termed "receding colors."

Some colors give the effect of warmth. Yellow, peach, and red are examples. Other colors, such as blue and green are associated with the out-of-doors, and are known as cool colors.

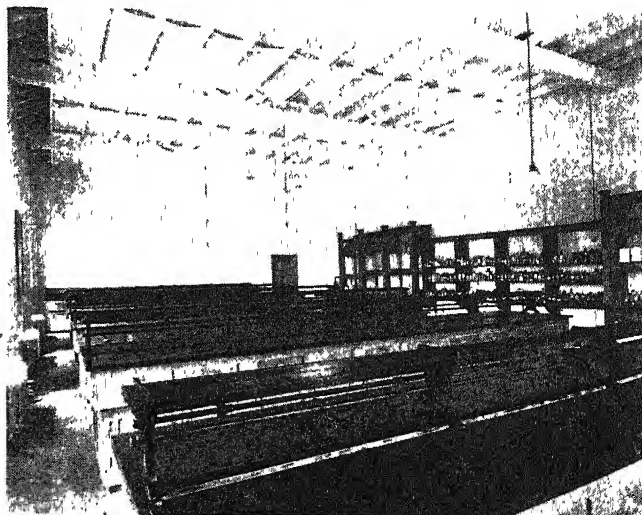
Then there are psychological factors. For example, red is known as the most powerful color of the spectrum. It is associated with strength, action, and has a tremendous influence on human moods. Yellow is gay and cheerful. Green is cool and refreshing, but neither exciting nor subduing. It is probably the most liked of all colors.

COLOR FOR INDUSTRY — The heart of the color idea for industry is the color selected for the machine. The choice is fairly wide and in general is not confined to a single color. The machine's color should have a fairly high light-reflection value to build up the brightness of the immediate surroundings to approximately that of the task itself. Machinery should have a semi-gloss finish which, while practical in every sense, reduces highlights and glare to a minimum.

In some operations the task is performed to best advantage when the tool or piece of work is silhouet-



Unpleasant working conditions—laboratory before painting



Light and cheerful—same laboratory in harmonious colors



Neutral background for colored yarns, good lighting for inspection needs; this knitting mill uses white ceiling, ivory walls, silver-gray dado, red striping

ted against a light background. A silhouette color is also effective as a reflecting background to bring up the brightness of the immediate surroundings to correspond to that of the work. Reflecting areas which will throw a uniform light on vernier surfaces and working lines should also be painted with the silhouette color. In some cases a two-tone effect is desirable, in which case a lighter shade of the machine enamel itself is used.

The accent color is a small area of pure color appropriately harmonious with the machine enamel. It serves a dual purpose — to indicate points of danger, operating levers, and buttons; and as a decorative feature by adding the interest value of a small area of bright color.

ROOM COLORS—In large plants it is not always practicable to select a single color scheme which will meet all conditions throughout the plant. On the other hand an abrupt change in color from one department to another is equally objectionable. The use of related colors for adjoining rooms provides an excellent solution for this problem.

Experience proves that there are three essential steps to doing a first-class color job in an industrial plant. First, equipment must be arranged in an orderly manner and miscellaneous items such as stock piles, lockers, and switchboards must be removed and put into separate buildings wherever possible. Anything that tends to clutter up the plant and give the impression of disorder must be carefully rearranged.

The second step is to provide pro-

per illumination. It is impossible to make a good-looking plant without correct arrangement of the interior; neither can an efficient plant be made without proper lighting. Painting in the right colors is important to good light, but no amount of painting can overcome the handicap imposed by glaring lamps directly in the operator's field of view, or in sufficient light at the working level.

The third step is the selection of an appropriate color scheme. Here, careful consideration of all of the foregoing principles comes into play. On an extensive job, technical advice from specialists in the color field is generally helpful and leads to a better appearing plant in the end.

Planned painting is not new on the industrial scene, but the next several years promise a much wider use of this production-boosting, morale-building, and economical technique.



ATOMIC POWER PLANT

*Now Designed for
Experimental Uses*

THE FIRST atomic pile specifically planned to produce power, has been designed at the Metallurgical Laboratory of the University of Chicago, and is now in the blue-print stage. Unlike the piles—atomic reactors—used in the production of the atomic bomb, the experimental power plant pile will be operated at a high temperature.

According to Dr. Farrington Daniels, director of the laboratory, "the

low temperature at which piles have been operated in the production of the fissionable material used in the bomb is not efficient when heat for power is the aim." No insoluble problems of control or safety are involved in operating the pile at a high, rather than a low temperature, explains Dr. Daniels, but he points out that the power plant should be viewed as experimental—a pilot plant from which knowledge will be derived for subsequent development and exploratory work. On this basis new developments may bring the cost of atomic power down to a point where it can supplement coal and water power, but since the cost of fuel, in this country, is only about one fifth of the total cost of generating electricity, no great reduction in cost could be expected even if atomic power should become cheaper than coal.

Dr. Daniels predicts: "It is for outlying regions where transportation is difficult and for locations where neither coal nor water power is easily available that atomic power plants will probably find their first use."

ARTIFICIAL LIMBS

*Offer Challenge to
Ingenuous Inventors*

A PLEA to American inventors and mechanical engineers to develop better artificial limbs was issued recently by Dr. Paul E. Klopsteg, Chairman of the Committee on Prosthetic Devices, through the facilities of the National Inventors Council, Department of Commerce. Stressing the urgent needs of 17,000 war amputees and an estimated annual minimum of 25,000 civilian amputees, Dr. Klopsteg urged inventors and engineers to submit ideas and suggestions for better prosthetic devices for analysis and screening.

Acknowledging the ingenuity of American manufacturers in making artificial limbs, Dr. Klopsteg pointed out a number of pressing problems as still requiring solution. Needed to solve some of these problems are improved ankle, knee, hand, wrist, and elbow joint mechanisms; materials lighter than those now being used in artificial limbs, but with sufficient strength; new fabrication methods; and further fundamental study of the mechanics of human motion. Also improved fitting procedures are needed, as are techniques for describing and teaching these procedures.

The Committee on Prosthetic Devices was set up in April, 1945, under the sponsorship of the National Research Council of the Office of

Scientific and Research Development. It is now supported jointly by the Army and the Veterans Administration Consisting of three orthopedic surgeons and three engineers, the Committee initiates, supervises, and lends financial support to research institutes and laboratories willing to undertake special research problems for improving prosthetic devices.

Members of the Committee have prepared a report especially for engineers and inventors, summarizing its work over the past year and analyzing problems as yet unsolved. A mimeographed copy of the report will be mailed free of charge upon request to the National Inventors Council.

MICROBE TRAP

Samples Purity of Room Air With Static Electricity

DEVELOPED as an aid to effective war against disease-spreading airborne micro-organisms, a portable electrical air sampler is described as capable of revealing a reasonably accurate "count" of invisible microbes in the air at various times. The new device, about the size of a shoe box and weighing but 12 pounds, is called the Duplex Electrostatic Air-sampler.

The unit has two important uses. One is in computing the amounts of germicidal-lamp energy needed to keep airborne bacteria reduced to a minimum for human safety; the other is in checking the effectiveness of germicidal-lamp installations. Equipped with an electrically driven blower, the General Electric air sampler "inhales" air at the rate of half a cubic foot per minute. Static electricity is used to attract the germ-laden particles out of the air stream.

The attracted air particles are intercepted by Petri dishes coated with a nutrient jelly. The bacteria captured on the Petri dishes are then incubated for about 40 hours at a temperature most favorable to their growth. Quantitative and qualitative bacterial counts are made from the germ colonies which appear, by the end of the incubation period, on the nutrient jelly.

Put to use in a cafeteria, the sampler revealed that the average number of organisms per cubic foot of air during the lunch period was 27. The maximum number varied from 44 to 88 per cubic foot of air. After the cafeteria had been emptied of its people, the bacteria count dropped down to 15.

As regards the effectiveness of germicidal lamps, tests made in a germ infected poultry-house showed that a system of germicidal lamps reduced the number of airborne bacteria more than 75 percent after as little as an hour's treatment of the air. These tests, according to the designers of the sampler, are now

being extended to include germicidal-lamp installations in the human field.

THERMISTORS

Detect Temperature Variations of One-Millionth of a Degree

EYES that see the warmth of a man's body in the dark a quarter of a mile away, that locate ships at night, and the chimneys of factories by their heat radiation were recently demonstrated as potentially valuable to industry. These devices, a product of Bell Telephone Laboratories, are built around tiny elements called thermistors, substances which have such unusual electrical sensitivity to heat that they can detect temperature variations as small as one-millionth of a degree, Centigrade.

Developed originally for use in telephone networks and mass-produced by Western Electric Company, thermistors are reported to hold promise of increasing the precision of temperature measurements tenfold.

Thermistors stem from a group of materials known as semi-conductors which are interesting because their electrical reaction to temperature is the reverse of that in normal conductors. When semi-conductors are cold, their resistance is high; as their temperature increases, their resistance drops rapidly, an unusual behavior.

As an example of the utility of these materials it is pointed out that standard precision thermometers, which use the resistance of a platinum wire as a temperature scale, are accurate only to a hundredth of a degree. With apparatus no more elaborate, however, thermistors can gauge variations of five ten-thousandths of a degree.

A proposed large-scale adaptation of thermistors for war purposes was based to some extent on the idea underlying instruments known as "bolometers" — very sensitive heat-detecting devices which astronomers have used for some years to measure the heat radiated by distant stars. With the new heat-sensitivity provided by thermistors, it seemed possible that bolometers could be devised to detect the lesser heat radiated by such non-incandescent objects as men, vehicles, ships, and factory chimneys and provide observable indications of the heat.

Several equipments of this type were successfully tested before the war ended. The basic principle was that heat rays behave in much the same way as light rays; hence they might be collected in a parabolic reflector which could be pointed at

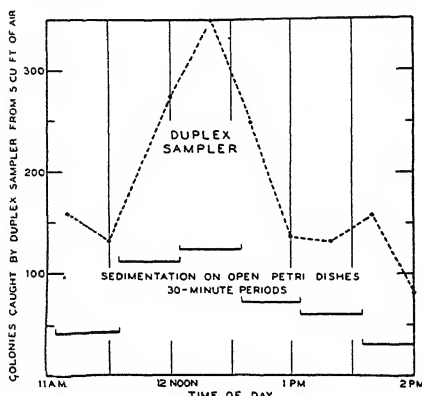
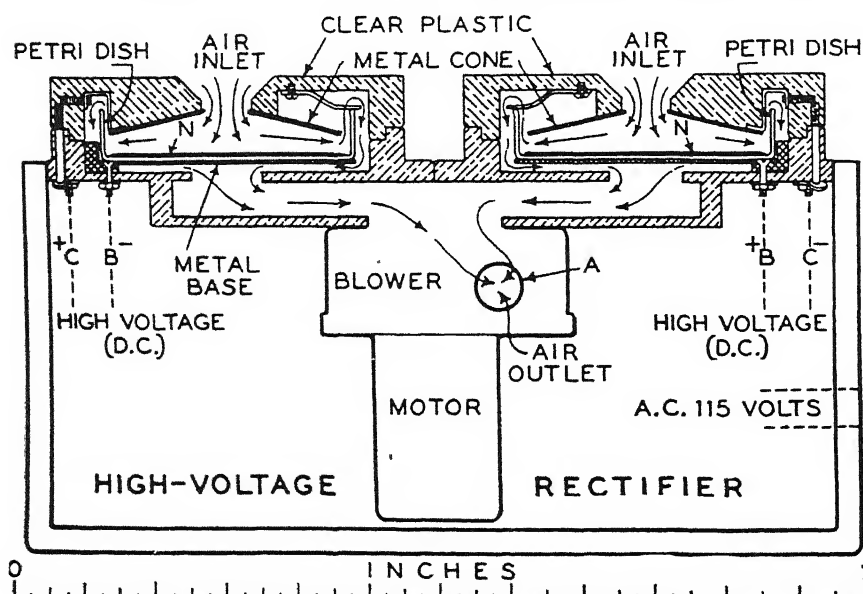
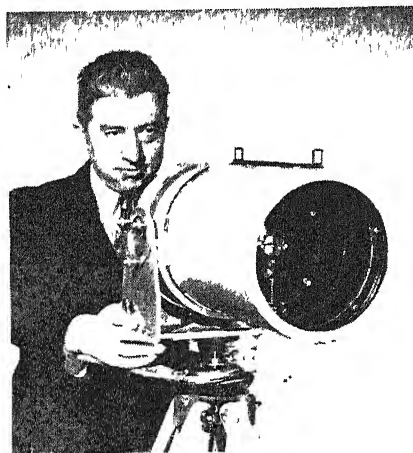


Chart (above) shows concentrations of airborne organisms present in eating area before, during, and after period of high occupancy. Section through an air sampler (below) shows Petri dishes and electrostatic attracting charges.



specific objects in the same manner as the reflector of an astronomical telescope. This reflector focussed the "black light" radiation of the object on the tiny thermistor element, which was connected with an amplifier to signal any change in the heat it received

Evidencing the sensitivity of thermistors is the fact that where copper will double its resistance with a temperature rise of 300 degrees, these semi-conductors can halve their resistance with an increase of only 20 degrees. Used as automatic gain controls for long-distance amplifiers, there is at least one thermistor in most amplifiers in the nation's carrier cable network. The scope of this task is indicated by the fact that the power transmitted by a length of overhead cable between two amplifiers may vary in a magnitude as high as ten to one with the seasonal variation in cable temperature. Over a long cross-country cable this variation, if unregulated, could pile up to an almost incomprehensible factor, roughly represented by figure one, followed by 180 zeros. Thermistors restrict this immense potential change to a varia-

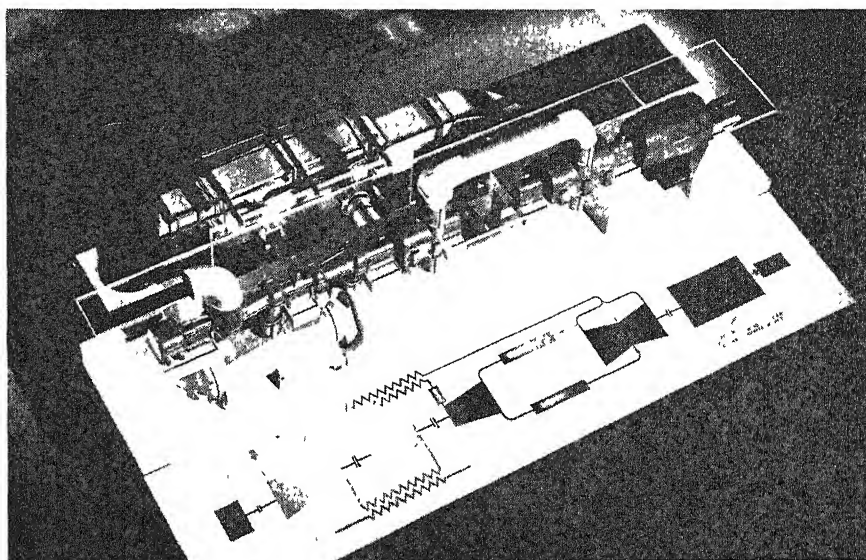


Thermistor-type bolometer can detect man's body heat at quarter-mile range

tion so small that it is virtually undetectable by the human ear.

A speck of semi-conductor, sealed in a glass bead little larger than a pinhead, does this job and replaces a complicated maze of equipment. In operation, the thermistor material is tapped into the amplifier output so that if the power increases, the thermistor heats up. As it heats, it passes more and more current through itself into an electronic valve which cuts down amplification. On the other hand, when amplifier output decreases below the proper level, the thermistor cools, cutting down the signal to the valve and thereby increasing amplification

Thermistors are described as having a wide variety of additional uses in and out of telephony. They can



Scale model of gas-turbine power plant—actual unit will have high efficiency

be balanced with resistors in voltage regulators to supply a constant output from a varying source or under varying temperature conditions.

Another example is their use as time-delay elements. This is based on the time it takes for them to heat up enough to pass the large and sudden surges of current sometimes fed to them. By varying the design of the particular thermistor and the circuit application, the time delay may be set anywhere from one ten-thousandth of a second to more than ten minutes

GAS-TURBINE GENERATOR

Proposed as Commercial Unit in 10,000 Kilowatt Size

BELIEVED to be the first commercial-design gas turbine actually proposed for power generation in the utility field, a new 10,000-kilowatt unit is now being studied in model form. Described as a high-temperature, high-efficiency version of this recently developed type of prime mover, the gas-turbine-driven power generating unit is designed for operation at 1300 degrees, Fahrenheit, and will have an efficiency of about 31 percent, according to the Allis-Chalmers steam turbine department.

At the same time the company has proposed another 10,000-kilowatt unit to operate at 1000 degrees, Fahrenheit, with the same guarantees as offered with comparable steam-turbine units—15 to 20 percent efficiency. It is believed that such a unit will have an application in the power-generation field.

Modeled for study on a scale of one half inch to a foot, the high-efficiency unit will occupy an actual area of about 4500 square feet.

An advantage pointed out for the gas turbine in certain power-generation applications is its ability to

operate without the great quantities of cooling water needed for steam plants. Standby uses are also said to appear promising

DDT CONCENTRATE

Has High Potency and Safety As Well as Long Life

KKNOWN as Pestroy, a new DDT concentrate is designed to provide farmers, stores, hotels, factories, public carriers, restaurants, hospitals, cities, and other commercial users with an economical, safe, and easy-to-use insecticide with high residual value.

Pestroy, developed by The Sherwin-Williams Company, is a 25 percent DDT concentrate. It is diluted with water to make a powerful repellent and insecticide which can be sprayed or brushed on any type of surface to destroy flies, mosquitoes, moths, gnats, fleas, roaches, bedbugs, silverfish, wasps, crickets, ants, and other common insect pests. A one-gallon can of Pestroy, diluted with four gallons of water to make a 5 percent solution of insecticide, will effectively cover 4800 square feet of surface. On interior surfaces, the residual deposit left by Pestroy will remain effective for from two to three months. A 5 percent solution of Pestroy will protect outside surfaces such as screens and doorways for from two to three weeks under average weather conditions.

Pestroy is odorless and stainless. When properly diluted with water it is fireproof. Continual freezing and thawing has no effect upon its effectiveness. While reasonable care must be taken to protect humans, household pets, and foodstuffs from repeated or prolonged contact with Pestroy, it can be safely handled without special protection and can do no damage to fabrics, wood, paint,

wiring, metals, or other materials. Pestroy can be mixed with kerosene instead of water, in the same proportions, for use on fabrics, carpets, upholstery, and other delicate materials where a water spray might not be suitable.

"COLD" TREATMENTS

*Speed Car Production,
Improve Metal Characteristics*

ASSEMBLY-LINE use of mechanical refrigeration is one of the new industrial techniques which is helping to speed production of new passenger automobiles. Installed on the engine production line, mechanical refrigeration equipment is being used to shrink steel valve inserts by chilling for permanent fitting into cylinder blocks, according to the Refrigeration Equipment Manufacturers Association.

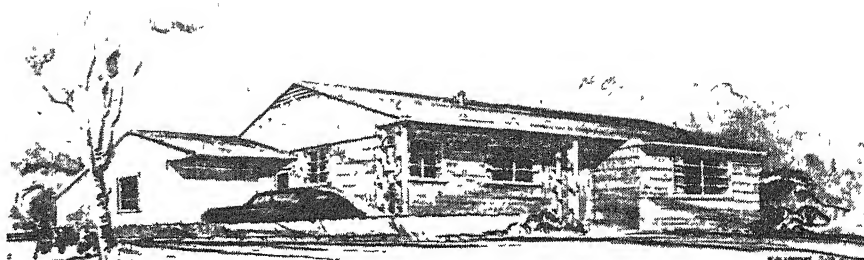
By chilling at a temperature of 120 degrees below zero, the inserts are shrunk two thousandths of an inch and are then automatically ejected for fitting into the cylinder blocks. At room temperatures, the inserts expand to normal size and become a permanent part of the block. Through use of this method it is possible to install the valve inserts at the rate of 360 per hour without interruption of the assembly line, it is reported.

Other industrial uses of refrigeration include "cold" treatments to increase the strength and ductility of auto body metal, and to lengthen the lives of high-speed drills, hack saws, and other cutting tools.

DUMP-TRUCK TRAILER

*Meets Contractors' Needs,
Eliminates Tractor Unit*

AN IDEA in trailer design that promises to be extremely useful to contractors, particularly those whose automotive equipment consists only of dump trucks, has recently been reported by The Lincoln Electric Company. The heavy-duty trailer has a "fifth wheel" built as an integral part of the design, arranged so that it can be mounted easily in



Four miles of wire, over 200 thermocouples will check heating in "typical" house

the bed of any standard dump-truck body. The arrangement not only eliminates the need for a tractor to haul the trailer, but also permits maximum maneuverability of the outfit as compared with the conventional, front-wheel type trailers.

The trailer platform has a deck height of 29 inches and is eight feet in width. Ground clearance is 20 inches, and the flooring is of air-dried oak.

The unit, designed and built by Mead Machine and Iron Works, has a capacity of 11 tons, is 30 feet long, and weighs 7745 pounds.

HOME-HEATING TESTS

*Will Be Conducted in
Typical, Family-Size House*

A ONE-STORY, 5½-room, modern home was built recently by the University of Illinois for the purpose of studying warm-air heating. This will be a co-operative project of the University and the National Warm Air Heating and Air Conditioning Association, which in 1924 in a similar project with the University built the world's first house constructed expressly for the home-heating research.

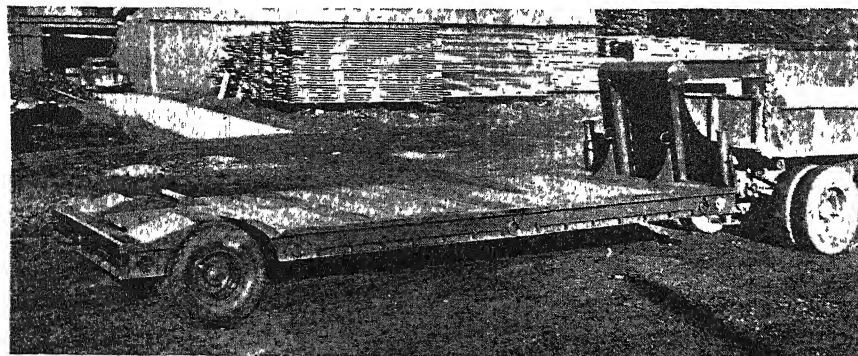
Study under actual home conditions in this earlier house is credited with providing the fundamental information upon which almost all modern warm-air home heating is based, and also many facts important to any type of home heating. This house has been used for research for 22 years, but it is an 11-room, 2½-story house, much larger than the typical American home of today

The new house will be typical in size of those being built now. It will benefit from the research findings and techniques developed in the older house, and promises to open the way for even better heating in homes of tomorrow. Like the older house, the new one will be completely furnished and will be occupied, to provide tests under actual home conditions. To obtain heating data, four miles of wires will be built into the house, connecting more than 200 thermocouples with a central switchboard for determining temperatures at many points in the rooms, in and on the heating plant, and inside the walls and other parts of the structure itself.

The first heating plant to be studied will be a conventional forced-air system whose main trunk duct will, instead of diminishing in size with distance from the furnace as in ordinary construction, be the same size throughout its length. If this proves successful, such construction can mean appreciable savings in labor costs for every forced-air heating installation made in the future.

Robert W. Roose, special research assistant at the University, who will be in charge of the new house, advises that the objectives for research include improvement of heating-plant operation and reduction of costs; study of air-transmitting duct layouts, heating-plant layouts, and heat distribution under controlled heat input; study of a house with a full basement compared with one having only crawl space under the floor; study of summer, home air conditioning, and study of new materials and ideas. As an example of the last, it was noted that the chimney of the house will be of a new type, made of molded asbestos instead of brick and mortar. Also another identical house without a basement but with the floor resting directly on the ground may be built later.

The basement of the house now being built will be arranged so that it can be separated from the rest of the house, and the heating plant put



Welded trailer mounts conveniently on fifth wheel resting inside dump truck box

into the utility room for studies of homes having no basements but with space under the floor.

Other features of the experimental house will be floors built with steel joists so that floor panel heating can be tried and walls built with panels instead of plaster, so ducts and equipment can be changed easily.

PLASTICS WINDSHIELDS

*Called Less Satisfactory
than Safety Glass*

EXPERIMENTS indicating that plastics currently are unsuited for automobile windshields were reported at a recent meeting of the Society of Automotive Engineers. Transparent plastics, it was explained, are difficult to clean, attract dust and road scum, resist wiper action during rainstorms, hold ice and snow, and quickly show a tendency to rattle.

As a result of various tests, it was claimed that even after three or four years of normal service in an automobile, safety glass windshields are superior to present transparent plastics after a few weeks' service.

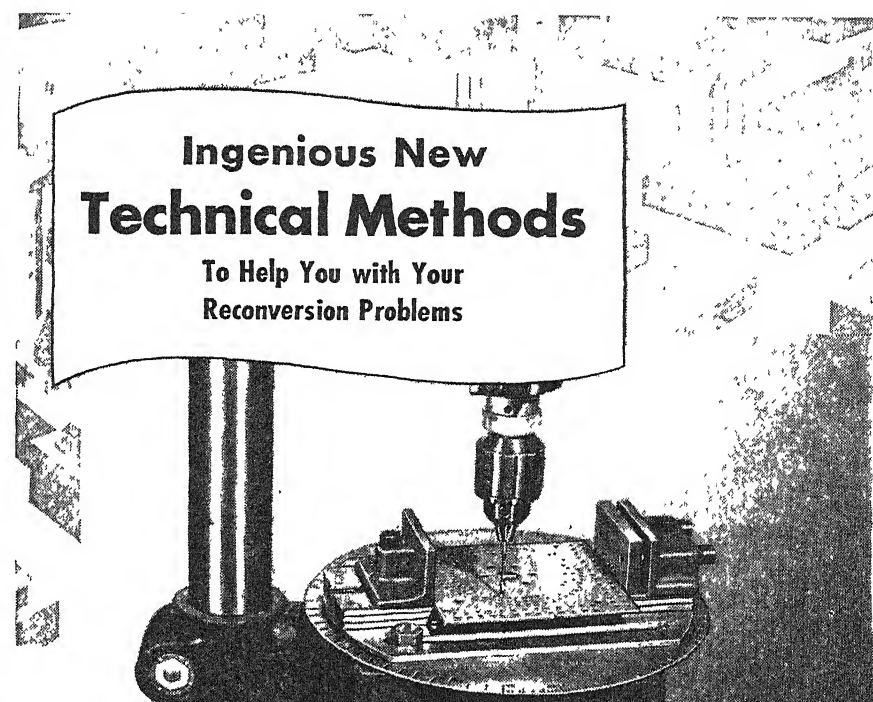
LOCOMOTIVE BOILERS

*Now Welded to Stop
Leakage, Reduce Maintenance*

FOR THE first time in American railroad history welded locomotive boilers are now being built. Nine years of experimental operation of a welded boiler built by American Locomotive Company in 1937 for a Consolidated-type freight locomotive of the Delaware and Hudson Railroad preceded the start of regular production. It is reported that the experimental boiler has been completely free of leaks during this period and all of the welded seams are still in excellent condition.

One important step in the manufacture of the boilers is the use of X-ray apparatus which greatly speeds up detection of flaws in metal. After passing X-ray examination, the boiler is stress-relieved in a furnace large enough to take the boiler as a unit. It is expected that the use of welded locomotive boilers will materially reduce boiler maintenance costs in railroad shops and will also reduce the time that locomotives are out of service for boiler repairs.

In discussing the earlier experiments with this construction The American Locomotive Company pointed out that before the first boiler was installed for road service in 1937, it was set up as a stationary boiler and operated for six weeks. Later it was mounted on a locomotive and examined every three months for the first year. All the



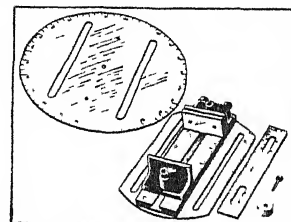
New, Simplified Drill Press Vise, Speeds Up Drilling, Spacing, Milling

Designed to be used with a drill press table having either parallel or radial slots, the New UNI-VISE drill press vise, with guide bar and protractor disc, speeds up and simplifies drilling, layout and spacing work in straight lines, radial or circular. With two movable jaws, vise has universal movement without swinging table or head of drill press to locate exact position of work. Operator thus adjusts work quickly for accurate registration.

Guide Bar facilitates drilling holes in a straight line. With a straight edge and a lineal scale on surface, it registers with lineal scale of vise. Protractor disc, for drilling holes accurately in a circle, has parallel slots registering with parallel slots in base of vise, and a removable means to pivot complete unit on table of drill press.

Accurate work can always best be done by attentive operators. That's why many factories urge workers to chew gum. The chewing action helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety. And workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy.

*You can get complete information from Spiral Mfg. Corp
3612-26 N. Kilbourn Ave., Chicago 41, Ill.*



AA-83

welded seams were carefully gone over and the second year the same procedure was followed every six months. Subsequently the boiler was examined once a year.

Several other advantages are claimed for welded boilers; these include the elimination of riveted joints which sometimes permit seepage between boiler plates even when the most careful fabricating techniques are employed. Boiler leaks are eliminated by welded boilers thus removing the possibility of cracked sheets which can be a major maintenance expense. In addition, the smooth contour of the welded boiler permits an easier application

of the boiler lagging and jacket and provides an equally smooth surface on the interior. This contributes to more satisfactory wash-outs by maintenance crews.

On many modern locomotives, it was noted, the saving of weight in the welded design over the riveted one is an important item. Depending upon the type and size of the locomotive, this weight saving may be from 3000 to 6000 pounds for the boiler alone, with additional saving in weight of lagging and jacket.

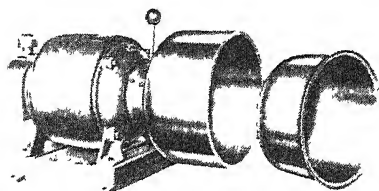
It is expected that a considerable number of welded boilers will be built for American railroads in the next few years.

New Products and Processes

SPEED LATHE

*Retains Work by Action
of Built-In Vacuum Pump*

A NEW model, heavy-duty, vacuum-grip speed lathe, introducing a built-in wet vacuum pump which holds work pieces without chuck or collet, has re-



Lathe Fixture Work Object

Single lever controls both brake and switch; stopping lathe releases work

cently been announced. Without the use of piping or glands, the pump generates its own vacuum that holds the work securely when the lathe is in motion, releases the work instantly when the machine is stopped.

Starting and instant stopping of the spindle are accomplished through a mechanical brake and switch that is controlled by a single lever.

The vacuum seal is created by drawing oil from a large reservoir into the pump early in the vacuum cycle. The oil is separated from the exhaust air on the discharge cycle and being recirculated requires only occasional replenishment.

Adaptable to both small or large work pieces, the Crozier Vacuum Grip Lathe holds metal, plastics, rubber, wood, or glass. A few of its uses include lens grinding, utensil polishing, utensil sunraying, disk valve grinding, trimming rubber products, removing flash from plastics products, machining copper disks, and polishing of ash trays and novelties. Motors are two or three phase, 220, 440 or 550 volts, 50 or 60 cycles, with several speed combinations available.

INSULATING WINDOW

*Multi-Glazed with
Sealed Inter-Pane Space*

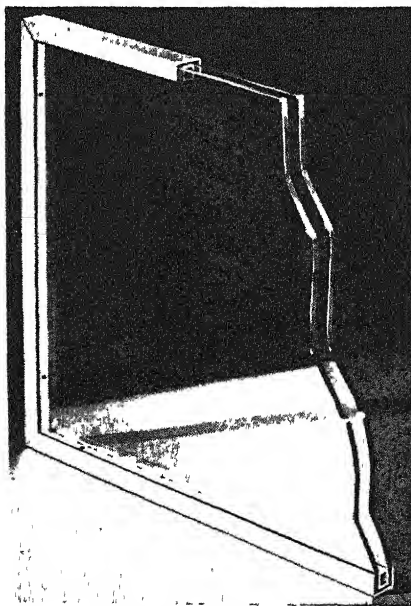
A NEW, double-glazed window-insulating unit for industrial, home, business, commercial, and special use, has been named "Twindow" and consists of integral insulating units of two or more plates of glass enclosing a quarter-inch or half-inch hermetically-sealed air space. One of the features of Twindow is use of hollow aluminum tubing to separate and hold the glass plates in position.

The entire unit is framed with a

light-gage, stainless-steel channel with the channel legs extending three-eighths of an inch inward on the surface of the glass from the base around its periphery to give maximum protection during installation and use. It is reported that the arrangement is an efficient thermal and dust insulation unit, and that it virtually prevents condensation. This, in turn, permits use of larger windows in offices, stores, and homes and at the same time appreciably reduces heating and air-conditioning costs.

The hermetically-sealed, dead air in the space between the plates of glass is held at atmospheric pressure. It is dehydrated initially by means of a drying agent within the aluminum spacer tubing which has access to the air space. The drying agent remains in the unit and provides added insurance against vapor diffusion and helps considerably in meeting more than normal atmospheric changes.

Clear, polished plate glass is used in construction of the standard Twindow unit. In addition, however, the units can be fabricated with special glasses to meet practically all needs. For example, special units can be made of Solux heat-absorbing glass and plate glass. Such units would be particularly adaptable for use in airport towers, large offices, or other locations where the direct rays of the sun pose a problem. The use of water-white plate glass, which permits true color definition with a maximum clarity of vision, would make this type of window convenient for use in test chamber multiple glazing. There are many other



Lower heat loss makes large windows practical—dehydration stops fogging

combinations of special glasses that can be used in fabricating Twindow units including polished wire, heavy plate, figured ornamental, sand-blasted, blue- and flesh-tinted, and various window glasses.

Special production processes make it possible to provide the windows in a wide range of sizes in any combination of straight edges. These units include the standard double-glazing as well as the special triple, quadruple, and multiple glazed panels. It is also possible to produce certain simple cylindrical bends within definite limitations, according to the manufacturer, Pittsburgh Plate Glass Company.

SCREW TORQUES

*Properly Set With
New Screw Drivers*

S MALL, lightweight torque-measuring screw drivers of the friction-disk type are claimed by the manufacturer to be very accurate in torque measurement and control. Known as "Tru-Torque," the screw drivers are manufactured in three standard sizes—small, from 0 to 6 inch torque pounds, medium, from 0 to 12 inch torque pounds; and large, from 0 to 25 inch torque pounds. They are designed for continuous service on production and assembly lines, and for maintenance work.

In operation, the screw driver is pre-set at the desired torque; when the



Handle slips at pre-set torque value

operator tightens the screw, nut, or bolt and the predetermined torque is reached the screw-driver handle slips and no further tightening of the screw is possible. There are no dials or spring mechanisms.

The tools come complete with one regular blade for slotted screws, one Phillips-type blade, and one Allen wrench and pin setter.

A beam stand is used for setting the torque screw driver. Reported to be accurate to a fraction of an inch torque pound, it provides large-scale readings from 0 to 25 inch torque pounds, and fractions thereof. Screw drivers are also available with sealed torque setting, as well as special torque measuring equipment.

TENSION BRAKE

*Uses Factory Air Pressure,
Adjusts for Accurate Drag*

A LINE of brakes designed to apply accurately controllable continuous tension in industrial machinery are available either as self-contained units or for building into new equipment.

Features of the brake, made by Linderman Devices, Inc., which make it suitable for applying continuous retarding force are the absence of self-

energizing action—permitting accurate control of tension desired, ability to apply even heavy loads under ordinary factory airline pressures; radial shoe actuation, eliminating sensitive adjustments and high pressure areas; and use of 90 percent of the drum area for braking.

In operation, the amount of tension desired is secured and maintained by setting the air-pressure regulating valve in the lead from the factory air line. Slight increases or decreases in tension are obtained by changing the gage setting, since the amount of braking effort is directly proportional to the air pressure applied.

This accuracy of control is said to be largely traceable to the elimination of self-energizing action. This also accounts for the smoothness of the brake in operation. Shoes are self-equalizing, full floating, with no localized high-pressure areas on lining or drum.

Also, the Linderman tension brake is described as unusually powerful due to the fact that the four shoes virtually fill the entire drum with lining. Since no high-pressure areas exist, higher average lining pressures can be used, it is claimed. Thus, under continuous load, a 14 by 4-inch brake will absorb from three to ten horsepower, based on a maximum lining temperature of 475 degrees, Fahrenheit.

Application of shoe pressure to the drum is through multi-stage steel diaphragms—one for each shoe. These diaphragms make it possible to use a minimum of expansion, since the shoe travel obtained is the sum of the expansions of each stage of the diaphragm. The brake shoes incorporate a wedge mechanism to adjust for lining wear. In the brake proper there are no operating parts which require lubrication.

Due to the closed design of the brake-actuating mechanism, the only air consumed is that required to expand the diaphragms to apply the initial pressure against the drum.

CONTINUOUS WIRE RECORD

*Plays Back Display
Message Without Re-Wind*

Use of the wire recorder for window or showroom displays, for voice tests, and as a device to attract audiences to booths at sales conventions or public displays has now been developed and several installations of this type of recording have been made, according to Lear, Inc.

The regulation wire recorder ordinarily requires that the wire be re-wound before it can be played back. For displays, however, the operation of the sound on wire must be continuous, hence it was necessary to construct a recorder for that special purpose.

For displays, the message is recorded on the required length of wire, and then the wire is mounted on drives in a continuous strip. The length of wire depends on the length of message required, and by a series of drives and posts, any length can be accommodated.

This wire keeps going through the playback head continuously, reproducing its message. It can be synchronized with the mechanical movement of the display, if desired, so that a constant automatic "demonstrator" can perform before the public without any personal attendant.

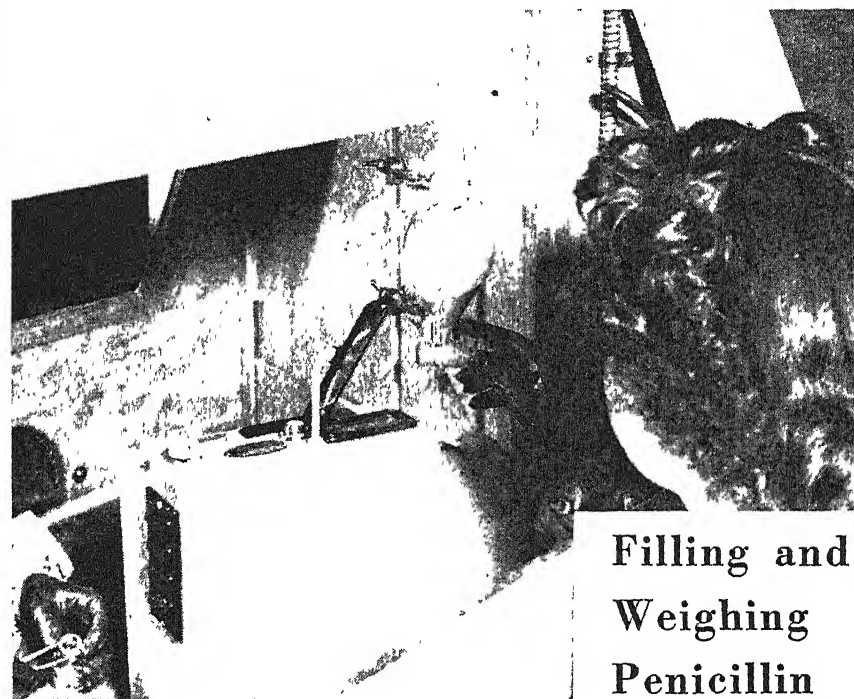
For voice tests and other purposes, a similar construction is used. In this case, the person picks up the microphone, speaks for a minute or two, and by the time he has finished his conversation, the part of the wire on which his first words were recorded has come around to the playback head, and is automatically played back to him. The length of time for recording can be regulated by the length of the wire.

This method does away with the

necessity of re-winding and it also saves cost and space since only a playback is required. The recording on the wire is done separately. By the use of two amplifiers, one for the recording and one for playback, no switch is needed.

One of the present designs, which permits about two minutes of recording, requires no more than a space three by five feet for the wire loop. This can be made even smaller, but in most cases the size is immaterial, since the wire can be placed anywhere, and only the speaker is needed near the point of contact with the public or the display.

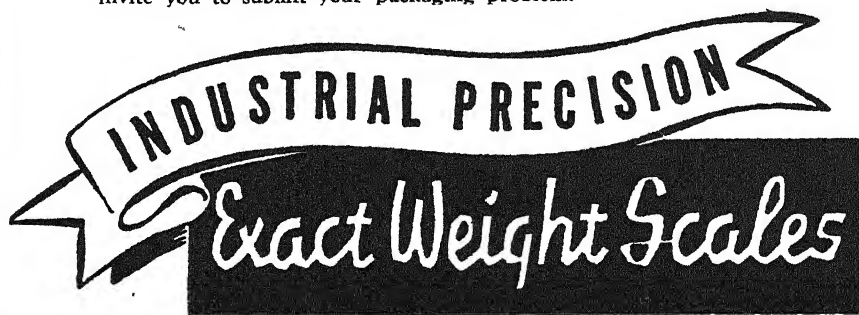
Although the present models have been constructed for special purposes, and used to a large extent as novelties



Filling and Weighing Penicillin

in Volume Production . . .

When Penicillin reached volume production it became necessary to apply volume packaging methods to this drug. The requirements were (1) extreme accuracy in weights, (2) speed of operation (3) packaging under aseptic conditions. These are exacting specifications but they have been met with the new EXACT WEIGHT Shadograph (illustrated). The unit above is enclosed in a glass case and operators work with gloved hands through apertures in the case to the sensitivity of 1 mg. This is but another use EXACT WEIGHT Scales have been put to in modern industry. We invite you to submit your packaging problem.



THE EXACT WEIGHT SCALE COMPANY

65 West Fifth Ave., Columbus 8, Ohio

Dept. Ad. 873 Yonge St., Toronto, Canada

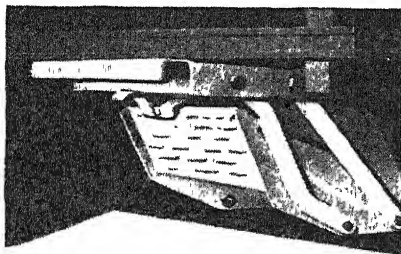
similar designs are being prepared to serve as automatic "information booths" for railroads, bus lines, and other public services. Answers to questions as to train time, athletic events, and so on are recorded on wire, and played back to the public when the button which carries such query is pressed. There is a large field for this type of recording in the commercial and amusement field; probably even more important than the field of home recording.

TRUCK STEPS

*Reduce Driver Injuries,
Swing Down for Use*

SAVINGS in money, time, accidents, driver fatigue, and a reduction in the number of hernia cases among truck drivers, are claims made for a new quick-acting, folding step for motor trucks and trailers.

The manufacturer states that these steps are intended for use on flat racks, stake bodies, vans, trailers, and semi-trailers, and are easily installed with four bolts. In closed position, the steps are compactly folded under the truck bed. When the trip is manually operated, two sturdy 16-inch slip-proof steps swing down and lock in open position ready for use. A slight lift and push on the bottom step swings and folds them back under the truck bed where they are automatically locked in closed position out of the way. One



In closed position, steps lock under truck bed; a trip-release lowers them

style of step is designed for side or "tight spot" mounting.

The steps are all metal and built to support a weight of 1000 pounds, although they weigh only 40 pounds. The tread plates are said to have an unusually secure gripping action.

It is claimed that drivers of trucks equipped with these steps show a pronounced reduction in the number of hernia and other physical injuries common to truck drivers. Large truck operators state that many hernia cases are caused by jumping off trucks. Also, frequent climbing on and jumping off heights ranging from 40 to 50 inches, sometimes dozens of times a day, contributes to driver fatigue.

The steps are manufactured by the Safety Step Company.

PRESSURE INDICATOR

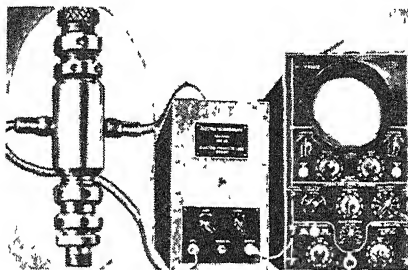
*Traces Operating Conditions
of Machinery on Tube Screen*

SUBSTANTIALLY linear pressure-time curves on the screen of a cathode-ray tube, connected to a new test instru-

ment, indicate the performance of an engine, pump, or other device subject to pressure variations. Intended uses are studies of internal-combustion engines, pumps, compressors, air and liquid pipe lines, and so on.

Called a Pressuregraph, the unit is said to show instantly the erratic operation of a device which normally cannot be observed by other means, due to inertia of flywheels and other factors. The instrument also shows static or slow pressure variations and covers all mechanical speeds and pressures up to 10,000 pounds per square inch. The makers, Electro Products Laboratories, say that there is no appreciable inertia to overcome in the electronic driving mechanism.

The pick-up unit has been designed



Inertia minimized for quick response

to make it vibration-proof, and is furnished with or without water-cooling. The cabinet is designed for mounting alongside the oscillograph in a similar cabinet, making a compact testing and recording unit.

In operation there is only one control. The pick-up is inserted in cylinder, chamber, airline, or a similar location and a diaphragm, when acted on by pressure impulse, unbalances an electronic circuit. The unbalanced voltage from the pick-up is delivered to the cabinet where it is amplified, passed through a negative modulation suppressor, and then sent to the oscillograph.

The sweep circuit of the oscillograph is adjusted to the speed of the engine or mechanism under test. A band of light appears on the screen, the contour or shape of which is the true pressure-time curve. This band of light is not a line or tracing, but an area similar to that of a television picture, and easily readable.

MACHINE VIBRATION

*Isolated from Other Tools
with Leveling Mounts*

A SIMPLIFIED, low-cost means of stopping the transmission of vibration from machine tools which interferes with precision work being done on adjacent machines is reported to have been found by the use of leveling-type machinery mountings. Called Vibro-Levelers, the units are intended as dual-purpose mountings for machinery—to stop the transmission of vibration and to permit leveling of the machine on which they are used.

In an example of such an application, four mountings, of 1000 pounds capacity each, were placed under the base of a

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself.

The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

shaper which had been causing transmitted vibration. After the machine had been raised from the floor, the threaded stud of each mounting was inserted through the hold-down bolt hole in the base of the shaper and the machine was then lowered so that it rested on the lower of two adjustment nuts supplied with each Vibro-Leveller. When the machine was brought to exact level, the second nut was turned down to lock and maintain the machine in the leveled position.

Time required for the entire installation was reported to have been less than two hours with no cutting of the floor, no special adapting of the mounting, and with the cost for mountings themselves being relatively low. In operation, the vibration interference was stopped and the "throw" of the shaper did not cause the machine to "creep" although the mountings were not bolted to the floor.

TURBINE TESTER

*Uses Resonance Principle
To Spot Incipient Trouble*

TO DETERMINE malfunctions of steam turbines, an industrial "stethoscope" has been developed. Turbines in normal operation have little characteristic noise, although tips of their blades may whirl more than 700 miles an hour. However, indications that something is wrong inside a turbine, may come with a hum, a wheeze, or some other unusual sound.

The part which causes the noise may range from a worn bearing to a "stretched" blade and can be determined by use of a simple formula, the



Tube length is adjusted to resonant wavelength of turbine "trouble" noise

resonance tube, or stethoscope, and the engineer's experience.

The resonance tube, a hollow plunger fitted into a sleeve, and varying in size from six to 60 inches, locates discordant sounds by tuning to the sound's frequency, much as a radio is tuned to the frequency of a broadcasting station. This is done by extending or retracting the plunger—at any one position only one frequency can be heard. By measuring the length of the tube at the position at which the noise can be heard, the frequency is determined, and by dividing the known velocity of sound by the frequency, the wavelength of the noise is determined.

Wavelengths of "trouble sounds" have been pre-computed and charted, and the particular fault of the machine tested is revealed by comparing the calculated wavelength with the chart. Since minor repairs may be made without tearing down the whole machine, thus precluding major difficulty, the industrial "stethoscope" saves time and money and assures quieter and more efficient performance.

FLEXIBLE COUPLING

*Constructed as One Unit,
Is Easily Installed*

FOR OIL burners and air conditioning units, and also applicable to many other machines requiring maximum flexibility, a new coupling is described as compact and easy to install.

Of one-unit construction, the device, called a CX Double-flex coupling comes out with the shaft when pump or motor is removed. A standard body is permanently inserted into the molded synthetic rubber unit, this being permanently secured to the pump shaft by a set-screw. Molded into the other end are the sockets that engage jaws on the blower hub.

Other features of the coupling, made by Lovejoy Flexible Coupling Company, are quick assembly in dark or close quarters, no metal to metal contact, tight fit, no rattle, deep center hole for a firm grip on the shaft.

X-RAY ANALYZER

*Detects Impurities, Based
on Ray Absorption Principle*

A NEW kind of "seeing" instrument, whose X-ray vision can detect counterfeit coins, spurious diamonds, and certain impurities in many types of solid, liquid, or gaseous materials, has recently been developed. Called the General Electric X-ray Photometer, the device is a rapid, accurate analyzer able to indicate within a second or two the concentration of certain chemical elements in the presence of others.

Plus its potential role as a detective, the instrument is expected to find application determining sulfur content of oil, tetraethyl content of gasoline, ash content of coal, heavy metal content of glass, and concentration of fillers and impregnating agents in wood, cloth, and rubber.

The instrument operates by aiming an X-ray beam through the material

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6171-S*	32	171	1 00
6173-S*	34	65	1 00
6176-S*	38	131	1 00
6177-S*	39	63	1 10
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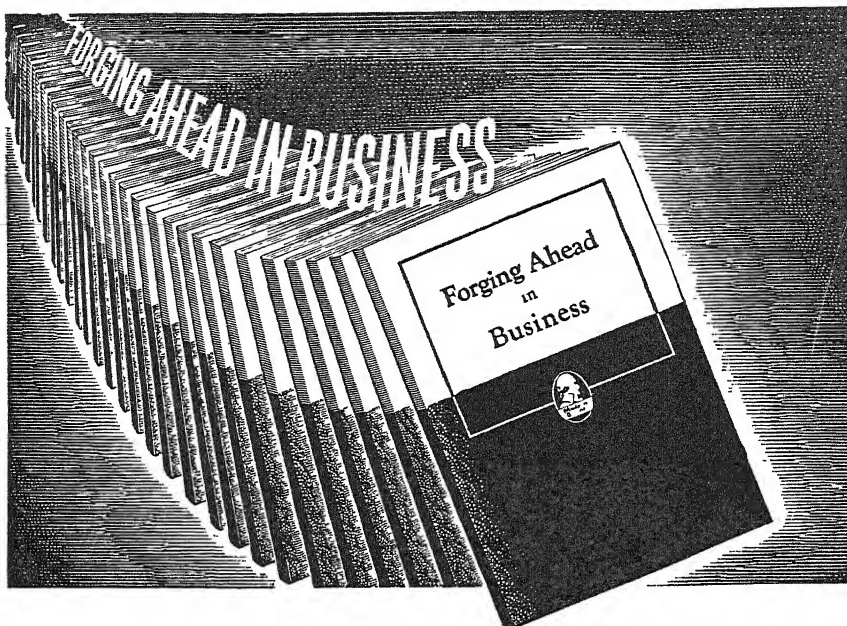
EDMUND SALVAGE CO., P. O. AUDUBON, NEW JERSEY

being tested and then measuring the amount of ray absorbed by the material. In testing a questionable coin, a genuine coin is first checked for its amount of ray absorption. The doubtful coin is then checked, and if its amount of ray absorption does not match that of the genuine coin, the doubtful coin can be assumed to be counterfeit.

In most other applications, however, the instrument employs aluminum disks of different thicknesses which act as proxy for the known item, against which the unknown item is being checked. In checking a diamond, for example, the stone in question is compared to an aluminum disk, whose thickness corresponds in ray absorp-

tion to a genuine diamond. Because genuine diamonds are almost pure carbon, very little radiation would be absorbed, whereas fake diamonds of glass, particularly if they have a lead content, would absorb a much larger amount of radiation, according to General Electric.

Estimating the amount of ash in a piece of coal without actually burning the coal is also possible with the X-ray photometer. First, the component chemicals of coal that result in ash are checked for the amount of X-ray absorption, and the aluminum disk which absorbs a like amount of radiation is selected. Then, the sample of coal is matched against the disk. Since



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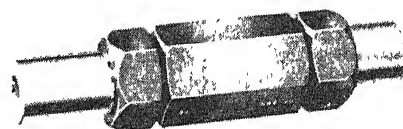
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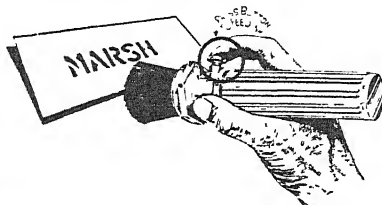
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The manufacturer, Marsh Stencil Machine Company, reports that a stencil can be marked in three seconds with the reservoir brush.

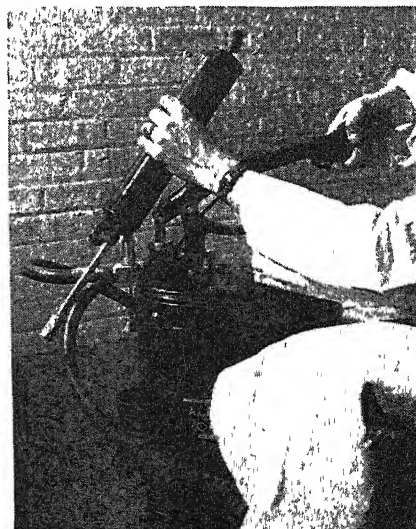
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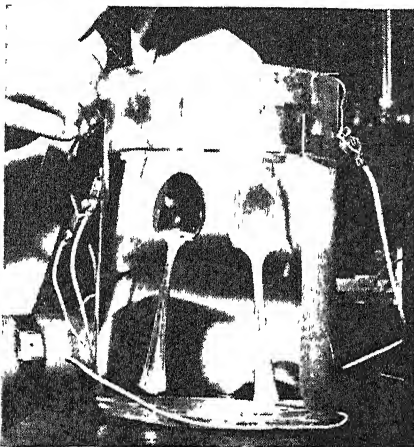
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SILVER POLISHED

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ACCIDENTAL use of a silver-plated wire in cleaning phosphor bronze electrolytically is reported to have given birth to a new polishing process that may be of major importance in the silver industry. Credit for the novel electro-polishing method was given to Dennis R. Turner, physicist in the electronics department of the Research Laboratories of the Westinghouse Electric Corporation.

It was explained that ordinarily metal articles to be silver plated are immersed in a bath of silver-cyanide



Before electrolytic process, polished spoon (left) looked like one at right

plating solution and negative current sent through, causing a deposit of pure silver upon the objects. When removed from the bath, they are evenly plated with silver but are white and lusterless. Hence, they must be buffed by hand on a revolving wheel. The buffing not only entails an extra handling of every piece but the loss of a certain portion of the silver through abrasion. Only by a troublesome, costly procedure can the lost silver be collected and reclaimed.

With the new method of polishing, it was found that the best product results from immersing the silver-plated object in a bath of silver cyanide solution normal to the regular plating operation. Instead of sending negative current through the bath as in plating, however, a positive current is applied at about four times the amperage used to plate the metal, but not continuously. The positive energy is applied for a few seconds, discontinued, then sent through again, and this intermittent action repeated for several cycles. When the article has reached its peak of luster, it is taken out of the bath, rinsed and dried as a finished, highly polished product. The entire

operation takes slightly over a minute.

So that the current is applied and interrupted at the proper and regular intervals, Mr. Turner connected a small motor with a switch that controls the intermittent flow of energy.

Although the electrolytic polish can be effected equally well by employing a plain cyanide solution, it was pointed out that the more practical way is to utilize the same silver cyanide bath used to plate the objects, rather than having to transfer them to another tank containing only cyanide.

Industrial practice, it is suggested, would be to immerse the metal pieces—many at a time—apply a negative current to silver plate them, then intermittent positive charges to attain the bright finish—all in the same bath. In addition to eliminating the buffing process, such a procedure would have the advantage of retaining in the original solution the small quantity of silver removed by the electrolytic action of the cyanide while polishing.

The new method has been successfully used to polish silvered contactors, items of switchgear, microwave apparatus, radar parts, and other devices needed in experimental work.

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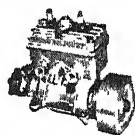
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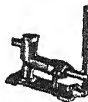
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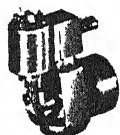
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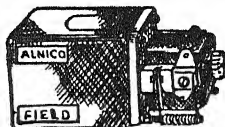
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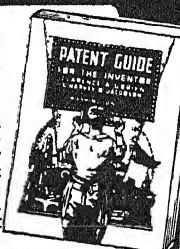
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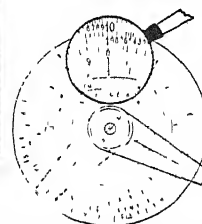
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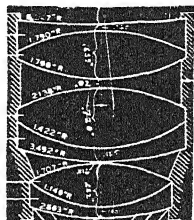
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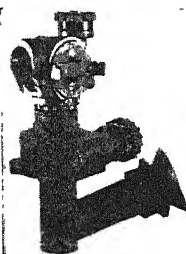
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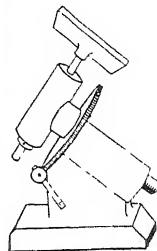
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LAST MONTH in this department George L. P. Arnold, a graduate student in nuclear physics, State College, Pa., offered extensive and definitive data on the design, testing, and performance of the Dall-Kirkham spherical secondary telescope. Figure 1, squeezed out of that layout, shows his telescope, a 10".

So well was the spherical secondary (why not simply the "s.s.") principle regarded some years ago (1938) when Kirkham referred it to those in charge of the 200" telescope, that it probably will be used on the tenth-scale (20") model. Before the 200" was built a 20" model was made and tried out, and that very interesting model was not afterward tossed on any junk heap or given to any of us T.N.s to get it out of the way (maybe we should have asked!) but instead it was mounted on the roof of the Astrophysical Laboratory at "Cal Tech" where it will be used in its own right. Last January, during exchanges of mixed telescopic lore with Porter such as have gone on by mail every few days since 1926, he wrote the following note in pencil on the bottom of a page: "In our tenth-scale Cass—our guinea pig—the primary was and still is spherical, as Dr. Anderson was in a hurry to get it working, and the secondary was corrected to fit it. Dr. Anderson is now computing the changes required in the primary if the secondary is made spherical and it seems that his procedure follows Kirkham exactly."

Your scribe recalls that at various times when "Kirk's" ideas were shown to Dr. Anderson via Porter they, and evidently Kirkham himself, were very well thought of. Telescoptics lost much when the genius Kirkham died after prolonged pathetic vicissitudes revealed in letters in files still preserved. "Kirk" was one day suddenly made highly aware that he had been ill with pulmonary tuberculosis for years, and it is a fact that his attempts to help other amateurs less well favored with a knowledge of design optics were a contributing factor in his fatigue and ultimate death. He wrote in 1938, when working on an invention: "If I can dope out a way to make diffraction gratings 10" long in a few minutes, I can go to the sunny southland—which I realize is about the only hope I have of living to see 1940." A proposal to collect a fund from amateurs was then made but Kirk apparently was not in favor of it. He died in 1943, at Pendleton, Oregon.

Returning to the Dall-Kirkham or, as Dall prefers, the Kirkham-Dall: In 1672 William Cassegrain proposed a

telescope having a paraboloidal primary and a secondary to suit, which called for a hyperboloidal convex. It is passing strange that he thus was able to set the mode for almost three centuries, when the s.s. telescope with spherical convex secondary and elliptical primary was just as obvious and simpler. Probably, however, he asked for the hyperboloidal convex simply because he had the thought fixed in his mind that a reflecting telescope necessarily called for a primary which was paraboloidal.

This leads to a new question. Since Cassegrain didn't, himself, invent the actual idea of a telescope having a secondary mirror and perforated primary, for Gregory had already published it in 1663 (Bell, "The Telescope"), and since he failed to find the spherical-secondary-elliptical-primary idea only recently found by Dall and Kirkham, is the Dall-Kirkham telescope then a Cassegrainian telescope of any kind or at all? Why isn't it simply the Dall-Kirkham telescope? Thus deposed as a child of the Cassegrainian, it becomes instead a brother of the Gregorian and Cassegrainian. If this is logic then this is advanced as the declaration of independence of the Dall-Kirkham telescope. In time it is likely to supplant the Cassegrainian. The poorer form was discovered first.

That it took nearly three centuries to find a thing so simple and so obvious (after the event) is perhaps a reproach to the past personnel of telescoptics. Another such reproach is the obvious and beautifully simple Schmidt principle, only recently hit on. During the two decades of this department's telescopic life many proposals for new



Figure 1: Arnold's s.s. telescope

principles have been submitted and many of them have proved to have been anticipated by someone or other. One gets the feeling that every possible avenue has already been explored and exploited, with nothing left to discover. History shows, on the contrary, that in such situations the unborn souls of more discoveries are flitting around invisibly overhead, eagerly waiting to be discovered and named for the discoverer. While most searchers evidently look for complexity, the best finds usually prove to be simple, like the s.s. telescope and the Schmidt.

BUILDERS of compound telescopes should, though they usually do anyway, work to a tight tolerance. Least squares treatment shows that when n surfaces reflect in a series, the tolerance should be $1/8\sqrt{n}$. On the 200" telescope six surfaces sometimes will be used in series, calling for $1/20$ wavelength. On a two-mirror telescope the tolerance is about $1/11$ wavelength.

CHAMPION member of the American Association of Variable Star Observers, Cyrus W. Fernald, of Wilton, Maine, with 7216 observations to his credit for the year, also Dr. William

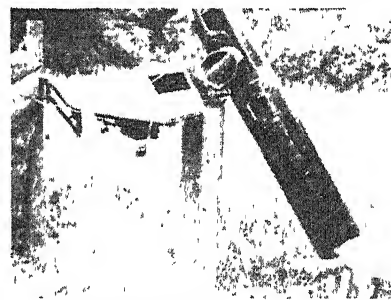


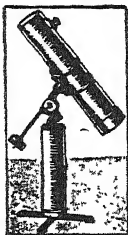
Figure 2: Reversing chart box

L. Holt, Scarborough, Maine, and Winter Park, Florida, who made the Association's millionth observation since its organization, both use telescopes having Springfield mountings.

In the Springfield mounting, due to the added reflection of the second diagonal, the star field is reversed and, as Porter himself comments, "disoriented" for any kind of chart work. Asked how he was able to reconcile this difficulty Dr. Holt replies: "Fernald and I would not trade our 8" Springfields for Clark 6" refractors. He has a geometrical mind and the reversal does not bother him. It does me, and so I have used, since I began variable star observing in 1932, a mirror chart box (Figure 2) which, when the chart is placed face down above a mirror, normalizes it. The box is shaped like a wedge and the upper, left-hand face as seen or, rather, not seen in the photograph, is a strong sheet of window glass. It has a hinged cover to keep the charts from blowing away. The level bottom has a plate glass mirror 12" square. The side shown at the right is mostly open, to permit viewing the reflected image of the chart. The closed part below the opening serves to shield the eyes from the weak red flashlight installed within.

"The chart box," Dr. Holt states,

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Harvard Observatory, Cambridge 38, Mass.

"is attached to the end of a swinging, extended bracket and can be put in just the right place on either side of the telescope pier, so that one looks down into it at about 30° (parallel to the glass back) and sees the chart, placed face down on the transparent glass, reversed. Thus the top of the chart becomes the bottom, but right remains right and left stays left. Finally, one has to adjust the chart on the glass back so that the east-west line corresponds with the east-west line in the sky as seen in the telescope.

"All this doubtless sounds complicated but it really very simple, both to make the box and to use it. It enables me to find and estimate magnitude rather carefully of 10 to 15 variable stars an hour. With the Springfield one wastes no time or energy and has no discomfort from nearly lying on the ground for a star, near the zenith or mounting a stepladder for a star near the horizon. I observe by the hour, sitting comfortably on the high stool shown at the lower right-hand corner in the illustration. This is an advantage of the Springfield mounting that Fernald and I swear by. We believe we are the only A.A.V.S.O. members using Springfielders."

Dr. Holt, a year ago, was runner-up for the A.A.V.S.O. championship. He observes summers in New England, winters in Florida, carrying the mounting and tube with him and attaching it to permanent pedestals having tops beveled to suit the respective latitudes.

Continuing in praise of the Springfield, Dr. Holt writes: "The most important of all advantages and the one which provides the chief explanation of the miracle by which Fernald finds, estimates, and records magnitude for 30 or more stars an hour, is the great ease in reading the setting circles, they can be read without getting off the stool. I have often worked for an hour or more and get 15 stars without getting off. Neither Fernald nor I use our finders or look at the sky at all in finding our stars; we just have the correct local sidereal time for the night and place, instantaneously (nearly!) subtract the star's R.A. from sidereal time or vice versa (I use a sidereal watch hung on the chart box), and set the star's hour angle and declination with help of the convenient slow motions, the whole process taking from 20 to 60 seconds."

CORNING casts mirror blanks up to 12 1/2" diameter in permanent iron molds and tries to keep them in stock, but above that diameter they have to build up a special, temporary mold from firebrick and the make-ready costs them more than the glass and the pouring. Thus a single 20" blank 3 1/3" thick costs the buyer \$225 and a 16" blank of same thickness \$140. But if 25 or more orders can be accumulated, so that the same make-ready can suffice for that many blanks, the price can be cut more than a little. Today the quotation is \$37.50 net for each of 25 or more 16" blanks.

In 1941, Clyde Tombaugh sponsored a Sixteen-inch Club in which Corn-

ing agreed to provide 16" blanks at similar price, provided 20 orders were received before pouring. This department (July and November 1941) lent its help and eventually Tombaugh was able to round up 33 members who ordered 37 blanks (this department, October 1942). These were delivered but the war sent most of them into temporary storage and only a few have yet emerged. Such holdovers tend unhappily to deaden the spontaneity of a group where each member knows others are doing the same job at the same time and knows who they are.

This department now proposes a new and additional or post-war Sixteen-inch Club of its own—though the Tombaugh group will be revived by its sponsor—and will take much interest in its progress and outcome. It obviously cannot undertake any kind of middle-man responsibilities of an actually business nature and therefore, pending accumulation of the 25 orders necessary to put the Club over the hill, orders and cash must be deposited with Corning Glass Works, Corning, N. Y. Two potential orders are now known of as a starter. Please keep this department posted; it cannot keep posted through Corning since, while C. F. Henkel, Jr., Corning's Manager of Optical Sales, is a friend of your scribe's (summers, we both bathe in and drink from the same lake and what more do you want?) this does not make it ethically possible for any outsider to snoop into company orders to see how things progress in order, if necessary, to do a little supplementary selling to reach the quota. The Tombaugh club started dubiously but in the end 17 more orders than were necessary came in. But those same orders partly saturated the market, also. Sightings are now set for 50 in order to hit the 25.

Tools. In 1941 some of the Tombaugh group bought 16" tools of plate at \$7.80 each from Pittsburgh Plate Glass Co., Ford City, Pa. Many prefer to work 16" disks (about 50 pounds) face up with sub-diameter tools on a modified Draper or other extemporized machine. If a 16" tool is used it possibly should be channeled as described by Ferson in "A.T.M.A." (printings after June, 1944) to avoid risk of sticking and for other advantageous reasons there described.

TEST for mirrors, described by H. E. Dall, Luton, Bedfordshire, England: "First, if a mirror is f/7 or longer focus a careful center-of-curvature Foucault test will be good to 1/20 wavelength. I favor using masks with 1/2" holes. Then put two short vertical scratches, about 1/2 mm apart in black enameled glass, in front of the test lamp and arrange a good 1/2" Kellner or similar eyepiece in front of the lamp on a measuring stand capable of measuring to and fro movement. Adjust the eyepiece inside focus to give four equally spaced bars of light. Mark the position and repeat outside focus. The center of these two positions is the zonal focus and this method is capable of better accuracy than most."



INDUSTRIAL DRAMA: A welding crew, working in harmony to speed automobile production, apply their welding guns to a body floor pan in one of the plants of the Fisher Body Division of General Motors Corporation

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50 Years Ago in . . .



(Condensed from Issues of October, 1896)

THE AMERICAN WAY — “Better the most cast iron conservatism than a liberalism which is lawlessness, that pulls down where it should build up, that sets man against man, class against class, and ultimately loosens those bonds, light as air yet strong as steel, which bind our great country into a union where we have proved that it is possible to have unity without uniformity.”

VANADIUM — “A new source of vanadium compounds has been found on the South American Andes. On one of the high plateaus a mine of anthracite has been located, which, when burned, leaves an ash containing vanadium and silver. The vanadium is now being extracted for use in making aniline black and coloring porcelain.”

HEATING AND COOLING — “A German inventor has built a house of tubes, whose advantages are, he says, a constant temperature and, incidentally, strength, comfort, and beauty. He first put up a frame of water tubing, allowing continuous circulation to a stream of water. Around this frame he put up his house in the ordinary way. . . In the summer, fresh, cool water circulates under pressure through the network of tubes and cools off the walls. . . During the long and severe winter the water entering through the basement is first heated to nearly 100 degrees and then forced through the tubes.”

PEARLS — “According to C. E. Benham, although a little of the color of the pearl is caused by striations or fine grooves on the surface of the nacre, the greater part of the color is produced by interference of the rays of light by reflection from the outer and inner surfaces of the thin layers of nacre forming the substance of the pearl. The colors of a pearl have, therefore, a similar origin to those of a soap bubble or the iridescence of ancient glass which has been scaled by time.”

DIRIGIBLE — “At the Berlin Industrial Exhibition there is to be seen a wonderful dirigible balloon. On August 28 and 29 this balloon rose to the height of about sixty-five feet, and was propelled in all directions, even against wind. . . The motive power of this elliptically built balloon is an eight horse power engine driving a double bladed ship's propeller, having a diameter of about three yards.”

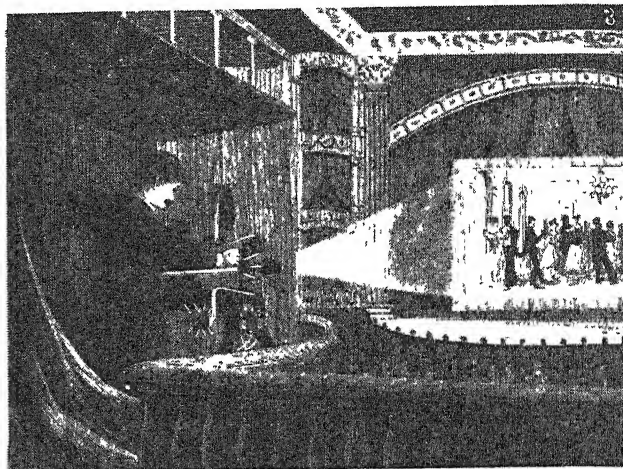
FORGES FORGE FORWARD — “The large brick forge and leather bellows, so often poetized and made the theme for the artist's pencil, is rapidly becoming a thing of the past. . . The portable forge and hand or power blower furnish a neater and more perfect forge than the old brick one in its palmiest days, and no modern smith would think of fitting up a new shop with any other.”

DIAL PHONE — “The Houts Automatic Telephone System provides improved means for allowing any subscriber in a system to instantly connect himself with any other subscriber without the aid of an operator at the central office. . . In making a call the subscriber presses the handle on the face of the call box, moving the dial forward until the number with which he desires to communicate is opposite the button at the left. The button is pressed, which fixes the position of the dial, allowing the handle to turn on until it again reaches the home point or falls into the notch from which the subscriber has started it.”

LIFE SPAN — “To what extent human life in the aggregate has been prolonged by better food and more of it, improvement in sanitation and the advances made in the scientific

treatment of disease, can never be statistically determined. But it is certain now that diseases are due to the operation of causes which are pretty well understood. Cities understand that they can no longer afford to have bad sanitation, and these improvements alone mean the prolongation of the working periods of men's lives.”

MOVIES — “Ever since the kinetoscope was brought to public attention and proved to be so popular, inventors have been striving to perfect apparatus for successfully projecting these miniature images upon a screen. . . Two factors in solving the problem have been the use of the electric arc lamp as an illuminant and of continuous transparent cellu-



loid flexible films. . . The pictures are made at the rate of twenty-five to a second, about three-quarters of an inch in diameter and one-quarter of an inch apart, on a continuous sensitized celluloid strip about one and a half inches wide, having perforations in its edges in which the sprocket wheels of the projecting device engage.”

100 Years Ago in . . .



(Condensed from Issues of October, 1846)

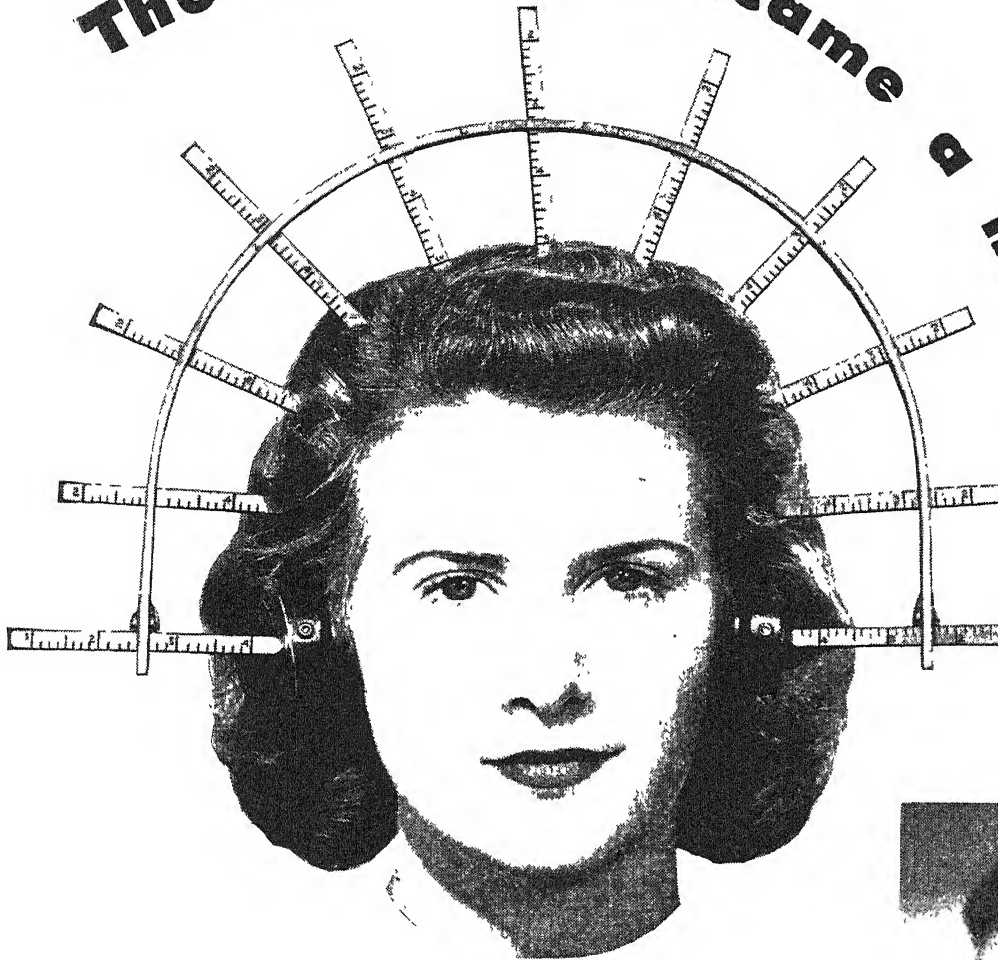
TELEGRAPH — “The Southern Magnetic Telegraph line, it is said, will be extended to New Orleans, via the Mississippi and Ohio rivers. It commences at Philadelphia, thence to Harrisburg, Pittsburgh, Wheeling, Cincinnati, Louisville, Saint Louis, Nashville, Memphis, Vicksburg, Natchez, to New Orleans.”

FREIGHT — “Experiments prove that railroads can be profitably used in carrying heavy freights at low rates, and that they will come into successful competition with navigable rivers. The experience of the past year shows that they can be successfully used in transporting southern cotton to the north, and in carrying the produce of the valley of the Mississippi to the Atlantic ports.”

IRON BOATS — “Messrs. Knapp & Foster, of Pittsburg, have completed four iron boats, intended for the use of the U. S. Army. These boats are each 45 feet in length, 10 feet in breadth, and 4½ feet deep.”

PAPER — “From statistical documents presented before Congress, it appears that the capital employed in the manufacture of paper in the United States is \$18,000,000. The number of mills, 700; the annual product \$17,000,000, and the number of operatives employed, 100,000.”

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Telephone operators in New York, Atlanta and Montreal wore the strange head-dress you see pictured above. It's a specially devised gauging instrument — Bell Laboratories' scientists used it to measure head contours in designing the new operator's headset.

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Previews of the Industrial Horizon

By A. P. Peck

NEW RESEARCH TRENDS

EVER SINCE research became recognized as an important tool of industry, much of the emphasis of the laboratory—perhaps too much of it—has been on the adaptation of materials to end uses. All too often the result of this type of thinking was to force a certain material into products that might better have been made from some other material which, unfortunately, had not been favored with the laboratory attention it deserved.

Now it appears that much of this thinking is being reversed. More and more the emphasis is being placed on finding the best material for a given use. And, to the benefit of all research, this sort of work is being forwarded by a far larger number of industrial organizations than ever devoted attention to promotion of specific materials.

Of a piece with this trend in industrial research which places product improvement ahead of materials used is the newer mode of testing which emphasizes performance of a finished unit rather than the basic characteristics of the materials which make up that unit. But for details on this phase of production research and testing, see the article by Contributing Editor Peters on page 199 of this issue.

To summarize this trend: More industries, large and small alike, can benefit from advancing technology if they will devote even a modicum of attention to the relationship between product and material. Perhaps, as examples, one of the light metals—aluminum or magnesium—can do a better job than the sheet steel now used, maybe plastics can advantageously replace the light metals, possibly old-fashioned cast iron has desirable properties which have been overlooked in the rush to use the newer materials. A searching—and continuing—investigation of the suitability of materials for the job in hand will usually pay out.

WHO WILL INVESTIGATE?

PART AND PARCEL of this newest phase of research, only now being appreciated, is the creation of departments for the purpose of forwarding special interests of industrial concerns, but unhampered by conventional rules and regulations of production or even research units. Such “unnamed departments,” dealt with by Contributing Editor Cady in the article starting on page 157, can unearth information of unusual value, especially if they are left to operate in the unconventional manner indicated by their namelessness.

All in all, a break from tradition is underway in research and semi-research departments. It will be the smart, and successful, company that recognizes the need for such a break and that gets the jump on competition by taking advantage of this new approach to an old need.

HOW IT WILL BE DONE

DESCRIBING their new pilot plant that will serve as a practical link between the laboratory test tube and the production line, an official of Corning Glass Works has this to say about the way in which they are attacking immediate phases of “new thought” research: “This plant will be equipped initially with one continuous furnace and the most modern machinery available, thus enabling us to conduct experimental work without interfering with the production schedules of any of our manufacturing plants. As our laboratories develop new products, manufacturing techniques for producing them at low cost will be worked out in the pilot plant, and the knowledge so acquired will be translated into commercial production units.”

Another indication of the trend in research today is the new physical laboratory built by Universal Oil Products Company, to be devoted to aiding its own and other oil refineries. Says the company:

“Up to 10 years ago, most petroleum research was in chemistry. But with the advent of catalytic cracking in the middle '30s, physical research has been playing an increasingly important role.”

In the new laboratory will be X-ray, ultra-violet, and infra-red equipment, together with an electron microscope, which will make it possible to conduct studies of the catalytic cracking process in all its aspects.

From such pilot plants and laboratories can stem new industrial knowledge that will be not only of immediate benefit to the specific industries concerned but to all allied industries as well. On such bases must the industrial future of America be built. The sooner this research philosophy permeates all industry, from the automotive and electrical giants to the two-man producers of cast concrete objects and plastics products, the sooner production can be expedited and progress turned to the benefit of all.

THE RIGHT TO FAIL

INSEPARABLY linked with the new research philosophy thus far discussed is “the right to fail.” When research departments of any kind are given the freedom to venture into new and hitherto untried paths, they must also be given the privilege to fail. If they are not, they will be so hindered in their operations that results will be practically nil. This is not to say that consistent failure can be considered as a sign of success, but it is to indicate that occasional failure should not be taken as a reason for discontinuing efforts in a particular direction. Research risks must be intelligent risks, must be carefully appraised in advance and thoroughly thought out before they are taken. On such a basis any research program which takes recognition of the problems involved and which takes intelligent risks will be the one to succeed, as compared with the one which, through ultra-conservatism, refuses to acknowledge the right to fail and, hence, finds itself so hide-bound by tradition that it follows those beaten paths which lead only to mediocrity.

FOR FUTURE REFERENCE

AIRCRAFT heating units—small, light in weight, economical of fuel—have been engineered and tested for application to home-heating purposes and should be available by the time these lines appear in print, first indication of this trend was mentioned on this page in March 1944. . . Newspapers by radio facsimile, on the horizon for years and specifically called for on this page in September 1945, will be given a service trial in a number of United States cities early in 1947. . . Where extreme heat, coupled with problems of corrosion, has to be dealt with, look to the porcelain enamel industry for solutions, based on war-time experimentation with engine exhaust pipes and mufflers. . . Aluminum's progress—current output is triple that of pre-war—is taking it out of the pot-and-pan field and putting it squarely into a number of construction jobs of considerable magnitude; aluminum is clearly one industry that is not caught with its plants down; it can and will produce as markets require. . . Lumber, our one replaceable natural resource, must be seasoned before it can be satisfactorily used; now comes a chemical solvent method of drying which reportedly beats the kiln process by four to one in time factor. . . When thoughts wander toward large corporations as patent monopolies, remember these figures as the latest available: Patents to individuals represent 43 percent of all issued; to small corporations, 34½ percent; to large corporations, 17 percent; to foreign corporations, 5½ percent.

METALS IN INDUSTRY

Tests Or 'Traditions'?

By FRED P. PETERS

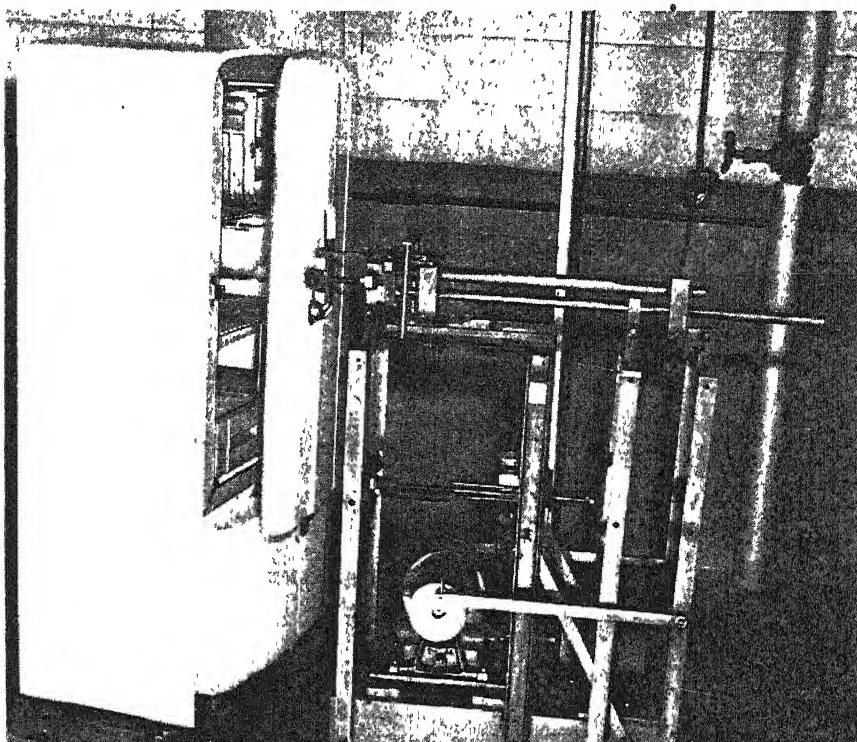
Editor-in-Chief, *Materials & Methods*

Conventional Materials Tests and Methods Have a Place—But Only If the Information Gained is Truly Significant in the Light of Actual Product Usage. Simulated-Service Tests are Often Much More Truthful, and May Indicate the Application of Previously Unconsidered Materials

AN OLD engineering maxim holds that "one test is worth a thousand opinions." Broader understanding of this principle has been a leading factor in the development of American manufacturing over the past three decades. Out of standardized-test methods have come not only better quality engineering metals and alloys, but also the uniformity of properties so essential to the reproducibility of parts and finished products. This latter, of course, is the keystone of minimum-cost mass production.

Now, however, another idea is fast taking hold and is expected by leading engineers to be the handmaiden of product and process development in the years ahead. A simple axiom for the idea would be, "One good test is worth a hundred bad ones!" Today, this concept is finding increasing application in the careful scrutiny of time-worn test methods, procedures, and equipment to see how much of their hide is bound to 1935 ideas; in the exclusion of "irrelevant" physical properties as major factors in materials-selection or design, even though the use of such properties and tests may have been standard practice for the past 20 years; and in the growing use of "simulated-service" tests, especially on finished parts or product assemblies, as against standardized tensile or fatigue tests on bars of the raw materials before processing.

SIMULATED SERVICE — This last phase is creating the largest ripples of all in today's testing circles, and as the simulated-service test wins new converts it is in turn inspiring



Courtesy Westinghouse

Simulated-service test on refrigerator door packs years of hard use into days

new highs in inventive ingenuity. Sometimes the simulation is a virtual duplication of service conditions; in other cases it is a highly simplified reproduction in the test of the one or two basic service factors that usually cause failure of the material or part when in use.

The case of bearing metals offers an example of such a problem. It is known that a multiplicity of factors—compressive strength, flowability, wettability, embeddability, resistance to galling or seizing, coefficient of friction, corrosion resistance, resistance to "fatigue" failure, and so on—are all involved in bearing service. At one extreme, bearing metals have often been appraised by

individual tests or a series of separate tests of tensile strength, ductility, salt-spray corrosion resistance, fatigue strength of polished bars, study of microstructure, and the like. At the other extreme—also used quite frequently—is the method of putting bearings made of the materials in question into an automobile and driving the car until the bearings fail.

The best practice, and the one used more and more by the better engine and bearings producers, is to devise a bearing-testing machine in which assembled bearings can be quickly and easily inserted, run at controlled and recorded speeds against whatever shaft materials are

desired, at selected bearing pressures and clearances, and under lubricating conditions that can be varied and controlled at will. Such tests are carried out on an accelerated basis that has previously been proved to rate the different bearings accurately with respect to the particular service conditions applied in the test. This preparatory and correlative work isn't always easy or inexpensive to do, but once done it pays dividends in common-sense results, in assurance of intelligent selection of materials, and in improved life of the product.

TESTS THAT AREN'T TESTS —

Some of the well-known "properties of materials"—and their required tests—that have been standard bases for materials-selection for years are now regarded unfavorably by capable materials engineers and metallurgists. "Ductility," for example, is usually measured by the standard elongation test, in which a test bar is pulled in a tensile machine until it breaks. The amount the bar stretches before breaking is expressed as a percentage—called the percent elongation—and is generally accepted as a reliable index of the ductility of the material.

Moreover, good ductility is usually considered a basic criterion of the engineering quality of a material—except by some of the more analytically minded technical men. To the latter, if ductility is actually re-

• LOOKING AHEAD •

Fewer failures in use of materials thought to be thoroughly tested. . . Reduction of manufacturers' losses on defective parts. . . Lower-cost materials effectively applied on basis of accurate test knowledge. . . Longer trouble-free service life of functional parts. . . Establishment of new standards for modern composite materials.

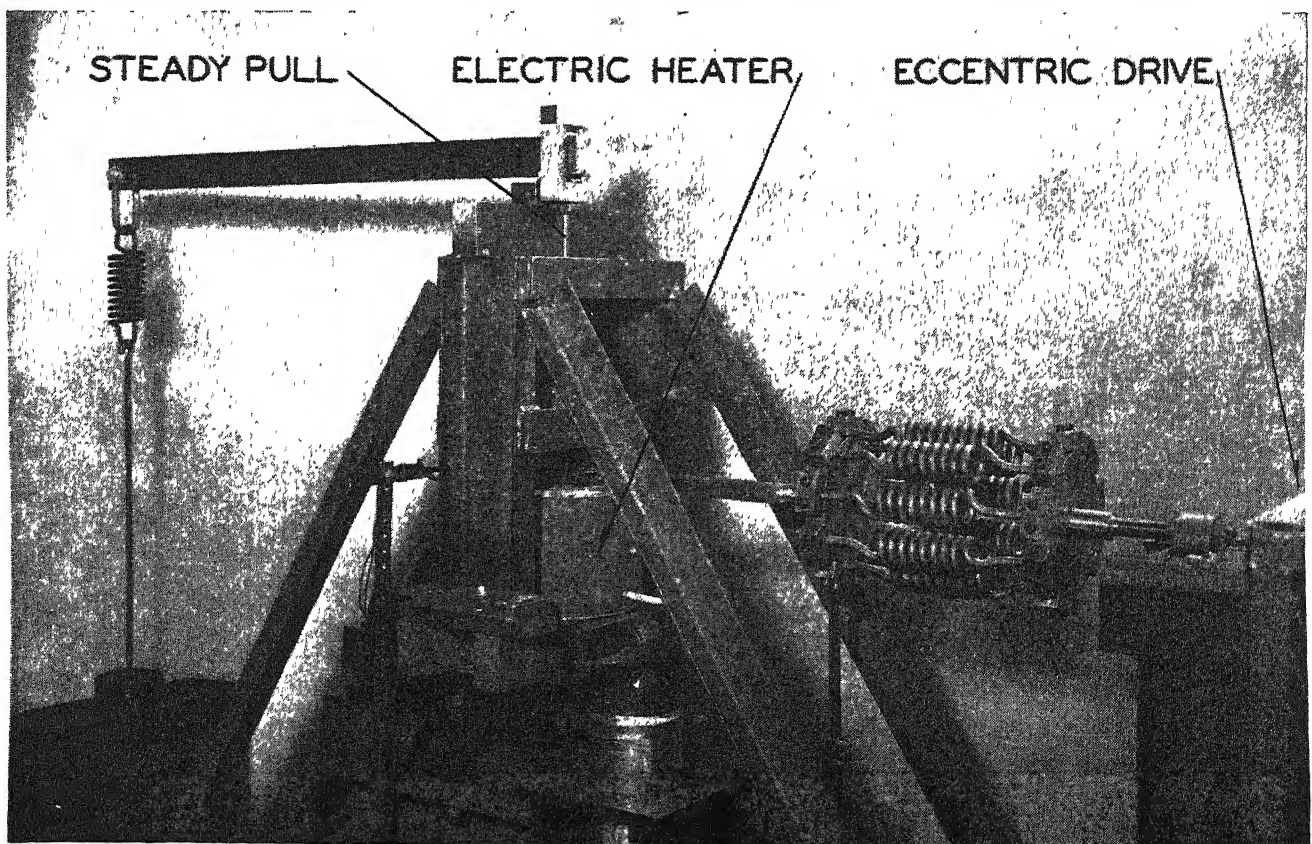
quired in the specific service to which the material is to be put, then ductility should be specified and tested for; but if the service involves no plastic deformation the ductility requirement is completely irrelevant and materials with test figures near "zero" elongation may, for entirely different reasons, be better for the particular service involved than those with 20 or 30 percent elongation.

With this common-sense engineering philosophy some of the oldest prejudices about materials are rapidly vanishing. Cast iron, actually a "brittle" or non-ductile metal, emerges as a first-class engineering material. Engineers recall that cast iron has long been used successfully for hundreds of structural purposes including machine-tool bases, certain types of bearings, motor frames, and so on, and proceed to apply modern,

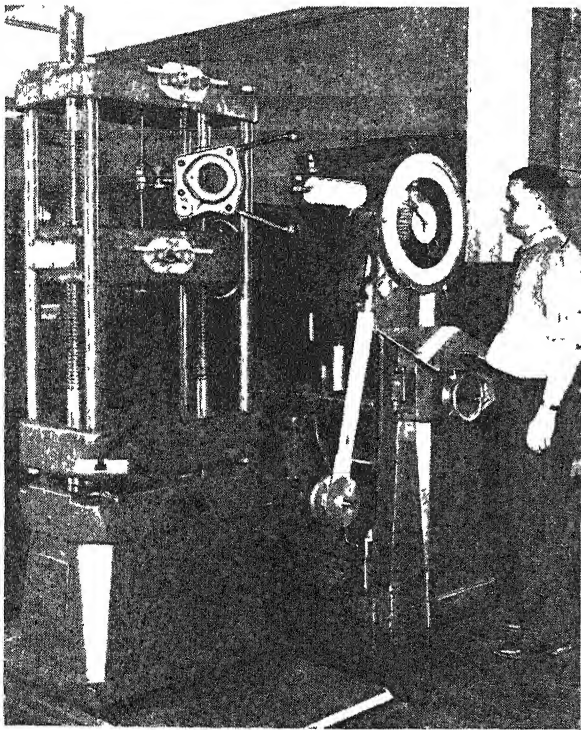
stronger, cast irons—still with relatively poor ductility—in crankshafts, forming dies, marine propellers, pumps, and elsewhere to marked advantage.

This policy of fitting the property-requirement and the test to the actual needs of the service involved is similarly applied to the impact test, a standard procedure in which mechanical shock resistance is measured by determining the amount of energy required to break a piece of metal, usually notched, by striking it with a hammer. Many engineers have sworn by the notch-impact test as the best single indication of "inherent" quality in a material. But it becomes a foolish method of rating or selecting materials for an application that does not involve sudden blows upon the metal or if the design of the part can be made to avoid notches, sharp changes in section, or other potential points of weakness.

Corrosion tests have notoriously been abused through their complacent application in situations where their results were actually misleading. Thus, the so-called "salt-spray" test, in which pieces of metal are sprayed with a salt-water mist fed through a circulating system, has been employed in many specifications and by many organizations as an infallible measure of corrosion resistance no matter what the actual service environment is to



A variety of forces act upon turbine blades. Test above reproduces the more important ones for study under controlled conditions



Left Testing of finished parts—a Buick knee-action member—and (below) of basic raw materials—battery of testing units at Aluminum Company of America—exemplify dual aspect of industrial testing problem

be For many sea-going applications the salt-spray test is a truly reliable index of merit, but for other corrosive services it is only coincidentally so, and for many uses the salt-spray test gives absolutely false ratings of alloy suitability

NEW MATERIALS: NEW TESTS—

The American Society for Testing Materials, pioneer in the standardization of engineering materials—specifications and test methods, has been quick to spot the evident weaknesses in the use of many of its own standard tests, and is now carrying out a program of establishing the actual limits to which standard individual tests on single materials can be employed for service-life evaluation. Searching studies are being made of the significance of ductility and of the services for which fatigue, impact, salt-spray, stress-corrosion, and other “pet” tests are really meaningful, and those for which they are irrelevant or downright misleading.

Even more important, the Society has established an administrative committee on simulated-service testing, with the stated purpose of studying, developing, and standardizing methods of tests of simple materials, composite materials, and fabricated parts in actual or simulated service conditions and environment, insofar as performance has a bearing on the properties of the materials.

The prime movers behind this whole broad trend have been the increasing number of “composite” materials—reinforced or laminated plastics, plated metals, metal-ply-



wood sandwiches, and so on—and the lengthening list of fabricated forms—die castings, powder-metal-lurgy parts, precision castings, impact extrusions, brazed assemblies, and deep-drawn shapes—in which materials are now placed in service. Each of the fabricating processes has its own effect on the quality and serviceability of the material; beyond that the material in the assembled product often behaves differently than it would before assembly or before processing.

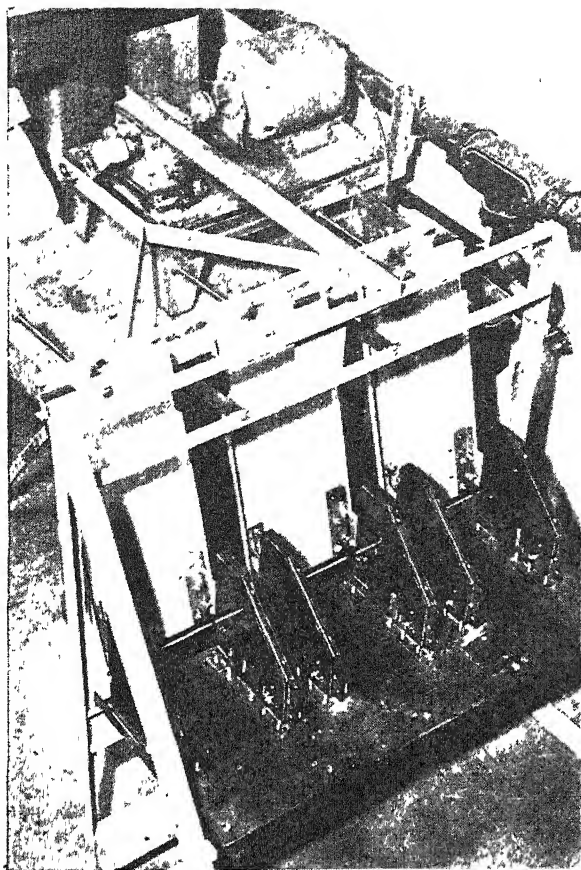
YEARS BECOME DAYS—Because of this last effect, one of the most fascinating of all testing fields—the evaluation of materials by simu-

lated-service testing of the entire unit in which they are used—is coming into increasing prominence. At a recent A.S.T.M. meeting a Westinghouse engineer described some of the unusual set-ups used by that company to give an accelerated but accurate measure of the way materials would perform in service. A refrigerator door, for example, may have a fine appearance and work well for a few times, but this is no assurance that it will function satisfactorily over a period of years. The spring in the latch could break, through fatigue; the latch and hinges could wear excessively; the sealing could become inadequate, and so on.

Therefore, in place of fatigue and wear-testing the materials or parts by conventional test methods, and in place of waiting for a housewife to open and close the refrigerator door to death, a machine was made which performs that operation continually—verging on the slamming

side for good measure—24 hours a day to failure. The machine operates at 15 cycles per minute, and an equivalent door life of 15 years is compressed to about 12 days by the robot door-slammer.

In another case, a test apparatus simulates the repeated sliding of a refrigerator tray or drip pan, as a check on the durability of finishes, materials, and the design of supports. And in still another check-up, a simulated-service fatigue test for turbine blades, the blade is heated electrically to simulate the temperatures reached in service, variable stress is applied through an adjustable eccentric, centrifugal force is simulated by a flexibly con-



Oven-door hinge and lock stop operate hour after hour in this service-type tester. Materials, as such, may have apparently desirable properties yet give a disappointing job performance. In other cases, standard materials tests do not indicate actual capabilities of material as it is used; hence, simulated-service tests

nected vertical pull mechanism, and so on—a far cry from conventional room-temperature fatigue tests on machined bars of the blade material. And these modern methods have led to important improvements in materials, design, and performance.

This is not to say that the fundamental properties of materials are of declining interest to engineers, or that conventional standard tests will ultimately be abandoned. On the contrary, designers are increasingly and intensively interested in learning more about the fundamental fatigue properties of stainless steel,

the notch sensitivity of zinc alloys, the flexural strength of individual plastics, and like subjects. With such information entirely new materials can more intelligently be developed, while such data can also be used for broad and preliminary weeding out of materials being considered for specific applications.

But there is a sharp trend toward using the conventional standard test *only where it has significance*, and developing simulated-service tests for evaluating application-performance where several complicated service factors are involved.

attractive on a price-per-unit-weight basis, and considerably more so on a price-per-equivalent-volume or a price-per-conductivity-unit basis.

ALUMINUM vs COPPER

*Battle Heightens as
Prices Approach Same Level*

HOTTER and hotter competition is expected between copper and aluminum for electrical-conductor applications in the future. Already aluminum—steel-reinforced—is preferred over copper for power-transmission lines, despite the still lower price of the latter on a weight basis.

But the trend is for aluminum prices to go down and for copper, if any change develops, to go up. Britain recently lowered its aluminum price below that of copper. American copper producers have sought a 15 cents per pound price for copper, which would make 14- to 15-cent aluminum slightly more

SILVER "SOLDER" BASE

*Applied by Brush or Spray,
Requires No Firing*

A NEW coating composition containing finely divided silver particles to be spread upon almost any material to form a "solderable" base for attaching metals has been developed. Several silver solutions have come out in recent years for firing onto a glass or ceramic base, but they must be heated to around 1000 degrees, Fahrenheit. In this newer compound, the silver particles are

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

combined in a solution of butyl methacrylate polymer dissolved in naphtha, butanol, or xylene. The coating can be applied by brush, spray, and so on to virtually any permanent base.

VIBRATION DAMPENED

*By Use of
Magnesium Castings*

MAGNESIUM is now finding new uses because of its vibration-dampening properties. Thus, one automobile maker has decided on magnesium-alloy wheels, both because of lightness and freedom from the vibration of steel wheels—the latter vibration is said to cause wear on the rubber tires. This maker is now experimenting with processes of manufacture, including sand casting. A maker of fishing tackle accessories has devised a magnesium reel. The light metal's dampening qualities are reported to make the reel silent and smooth in operation.

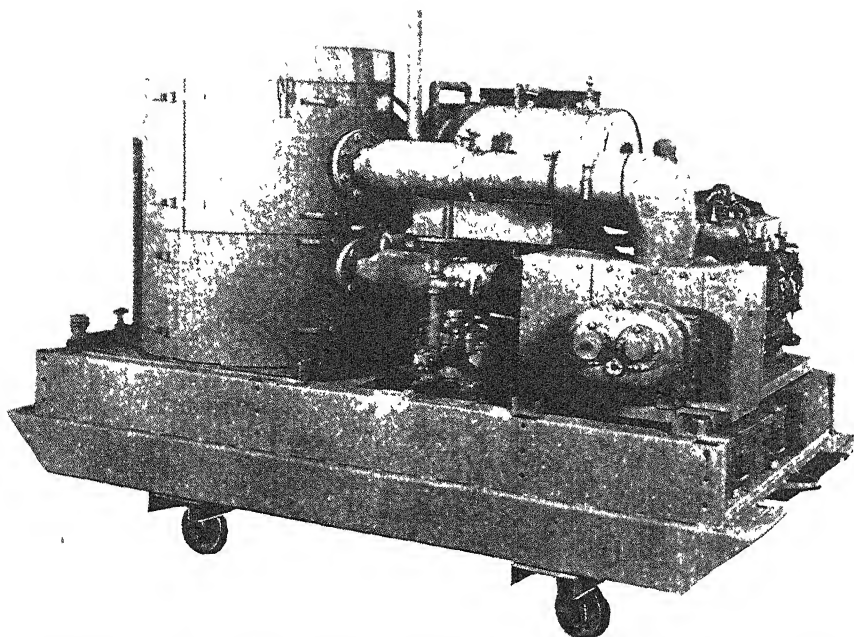
PRESSURE VESSELS

*Built Up of Multiple
Layers of Pre-Formed Plates*

A NEW method in pressure-vessel construction has been applied by A. O. Smith Corporation in the fabrication of large accumulator bottles for stored-energy systems and chemical processing equipment. This is the use of several layers of steel plate, each one rolled to a specified radius and then welded.

This type of construction permits the use in service of much higher working stresses than otherwise. Shatter failures through the built-up wall of the vessel never occur. The use of steel plate and welded fabrication also permits closer control over the quality of the pressure-vessel materials, since uncertainty regarding deep-seated flaws is eliminated.

In the chemical-process field, welded multi-layer construction also provides all the advantages of "cladding," since the innermost layers may be of a corrosion-resistant steel and the outer layers of ordinary mild steel.



Production model of Kleinschmidt compression still can be mounted on a trailer or skids. Capacity is 1800 gallons per day; water obtained is exceptionally pure

CHEMISTRY IN INDUSTRY

Making Heat Work Overtime

Basically Simple and Extremely Practical, Compression Distillation is One of Those Processes that Prompts the Unanswerable Question of "Why Hasn't It Been Done Before?" By Complete Heat Utilization, the Method Produces Pure Water Quickly and Economically, Yet Involves No Cooling, Uses Little Space, and Demands a Minimum of Attention

By D. H. KILLEFFER
Chemical Engineer

IT ALL started because the Navy needed distilled water for the storage batteries of its submarines—distilled water at low cost, lower than any yet known, particularly in terms of space inside the crowded confines of the submarine's narrow hull, and in terms of fuel that might mean precious extra miles, or hours, or speed for the vessel, and of man-hours of operating attention. All this was realized by compression distillation, but that was only a beginning. A whole war has intervened, with sea battles on the far reaches of the Pacific and invasions of waterless islands won, in part at least, because our men could supply themselves with sterile, fresh water when the enemy could not.

And even yet only beginnings can be reported.

Now that the basic problem of this new distillation system has been solved, the whole thing appears absurdly simple. Absurdly simple, that is, if it is simple to think of a refrigerating machine as a still, and to put it to work freshening seawater. In that respect, the Kleinschmidt compression - distillation unit has all the characteristics of a great invention—anyone could invent it now that he knows how. Which of course is no slight at all to Commodore R. V. Kleinschmidt, of U.S.N.R. and Arthur D. Little, Inc., whose invention it is. Quite the contrary.

The basic fact of distillation is

that the operation ends with the water just as it was in the beginning. The heat put in to vaporize the raw water is just equal to that taken from the steam to condense it. It is quite possible, theoretically, to distill water so that the heat given up by the condensing steam will boil an equal quantity of water. The whole process might thus be made self sustaining, but practice can never quite equal theory. What occurs in the Kleinschmidt compression still is the closest approach yet to that theory.

INPUT VS. OUTPUT—An analogy of gravity to heat or temperature makes the whole thing clearer. Distillation in those terms is equivalent to lifting a load to the top of a hill and then dropping it down the other side; like an inclined railway up a mountain whose car is pulled up by the engine and then allowed to coast down. In an ordinary single-stage distillation, this is just what occurs; energy is put into the water to vaporize it—carry it to the top of the heat hill—and then it is

• LOOKING AHEAD •

Application of pressure stills to food processing, chemical manufacture, biologicals. . . Increased use of distilled water in industries where cost is a large factor. . . Portable water supplies for construction crews, explorers, survey parties. . . More cargo space on ships large and small.

dropped down the other side—cooled. The heat initially put in is simply wasted.

This waste is not too bad if heat energy is plentiful and if water is abundant to cool the condenser and waste its heat. But these conditions seldom happen, and hence the thing to do is to recover as much as possible of the lost heat.

The case of the cable railway is quite different if a car going down is connected to one coming up by a cable running around a pulley at the mountain top so that the two cars counterbalance each other. Then the energy needed is merely the small amount required to balance the two cars plus another

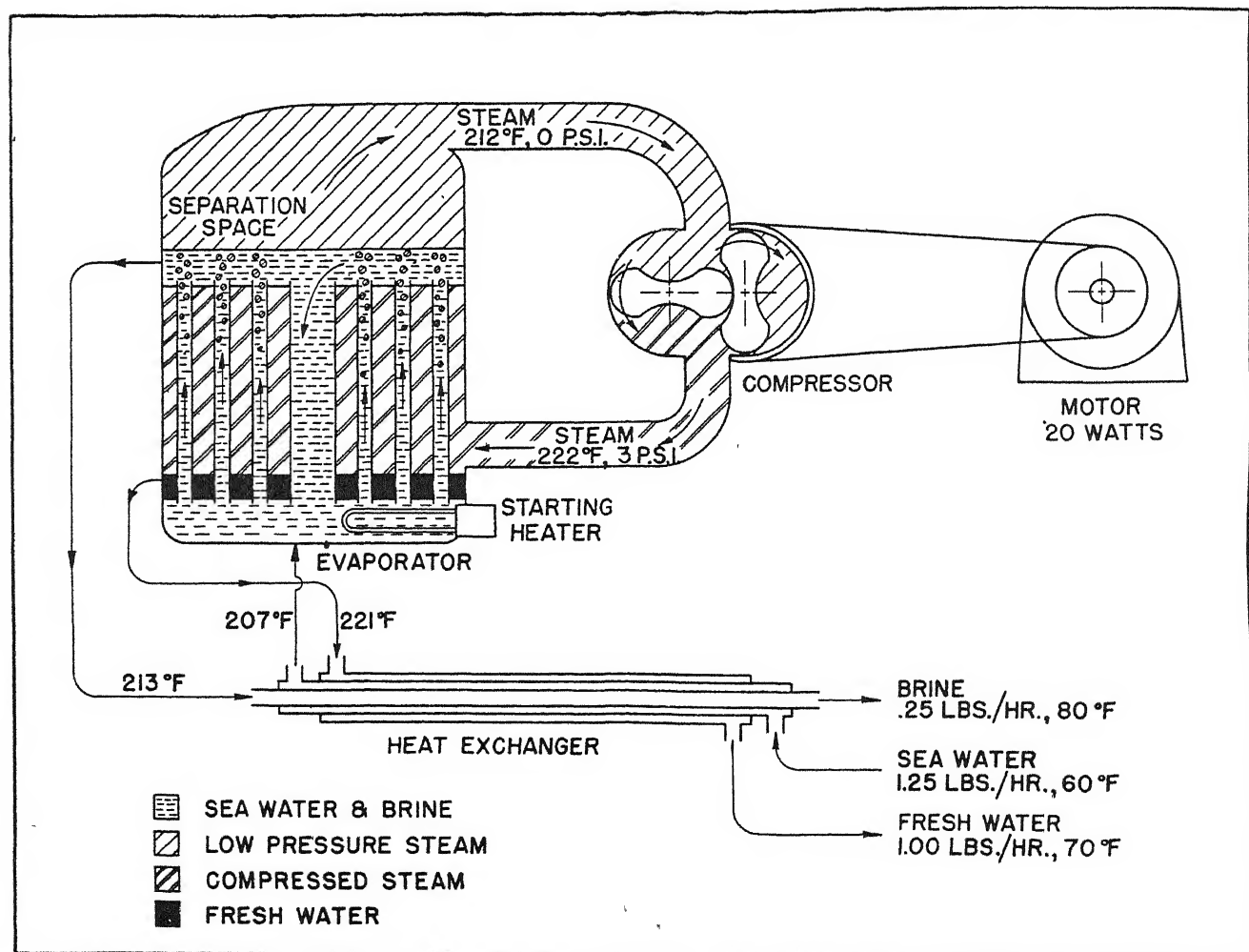
small amount consumed by friction. The engine need work no harder than would be necessary to move the two cars on a level. The difference is obvious—it is also tremendous.

Multiple-effect evaporation provides a number of stops on the downward slope of the heat-hill at which the heat initially introduced into the system is made to work again. In principle, a multiple-effect system should theoretically produce an almost infinite amount of distillate for any given amount of heat put into the system. The vapor from the first stage is condensed to heat the second stage, which is maintained at a slight vacuum to allow its contents to boil at a lower temperature than that of the condensing vapor from the first stage. As vapor from the second stage condenses, it heats a third stage maintained at a still lower pressure—higher vacuum. And so on.

Theoretically, any number of effects should be possible and the quantity of water distilled by the combination should be as many times that vaporized by the heat initially supplied to the system as

there are effects. In other words, a double-effect system should yield twice as much distilled water as the same amount of heat input would vaporize in a simple evaporator. A triple-effect unit should yield three times as much, and so on. In practice, the sizes of heating surfaces required, the temperature drop necessary in each step, the vacuum required, and other similar considerations limit multiple effects to three, or possibly four, stages for maximum economy. Only under most unusual circumstances is it practicable to go beyond that, and then only in units of immense size.

HEAT STAYS IN—The principle of the Kleinschmidt mechanical-compression distillation unit is quite different and is analogous to the cable railroad mentioned before. The heat to vaporize water is supplied by condensing the vapor boiled off from the same boiler. The heat of condensation is returned to the system through a heat pump operating on exactly the same principle as a mechanical refrigerating machine. Because only one transfer of the major quantity of heat is



All illustrations courtesy Arthur D. Little, Inc.

Figure 1: Schematic drawing of Kleinschmidt still reveals temperatures, pressures, and flow channels in conversion of sea water into fresh water and brine. No cooling water is used, process is continuous, and adjustments are both simple and infrequent.

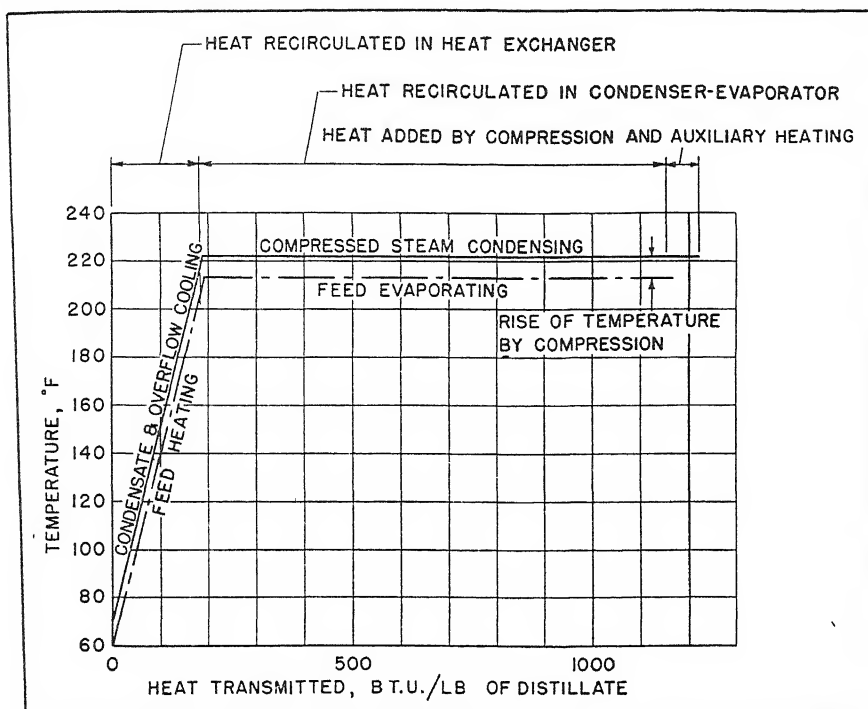


Figure 2: Temperature differentials maintained within compression still are fundamental to the ingenious heat transfer that gives system its efficiency

necessary, only a single resistance need be overcome by energy put into the system. Hence compression distillation units are many times more efficient than practicable multiple-effect system in terms of distilled water produced per unit of energy or fuel. Furthermore, the entire unit is self contained; requires no cooling water; is stable in operation; needs a minimum of attention from the operator, and yields sterile distilled water of highest chemical purity directly from seawater. The whole unit is so compact that losses of heat to the outside are extremely low, far less proportionately than would be reasonable for an ordinary multiple-effect installation.

Compression distillation depends upon mechanically compressing the steam leaving the evaporation compartment of the still to raise its temperature a few degrees. At the higher pressure, the steam condenses above the boiling point of the evaporating raw water, so that heat can flow from the condensing steam to the raw water and boil it. The complete unit includes insulation to reduce heat loss to the atmosphere and exchangers to recover heat from both the hot distillate and the hot, concentrated brine carrying off waste. No separate condenser and no cooling water are needed.

The process as applied to the production of fresh water from seawater is diagrammed in Figure 1. Initial pre-heating brings the apparatus and its contents to operating temperature. As soon as the evaporator is filled with steam, the still is

ready for continuous operation. The seawater feed enters through a triple passage, liquid-to-liquid heat exchanger to extract heat from the outgoing distillate and brine, and to heat the feed. The feed thus heated to about 207 degrees, Fahrenheit, enters the evaporator and mixes with a relatively large volume of brine circulating naturally through vertical tubes. Steam at, or slightly above, atmospheric pressure is led from the evaporation space through an entrainment separator to the compressor which raises its pressure to about three pounds gage. This raises its condensing—saturation—temperature to about 222 degrees. Since brine boils at about 213 degrees, a temperature differential of about nine degrees between the compressed steam and the boiling brine permits transfer of heat from one to the other. Substantially all of the latent heat of the compressed steam is thus transferred to the evaporation space and no separate condenser or cooling water is needed.

SIMPLE TO OPERATE—A unit of 1000-gallons-per-day capacity will yield one pound per hour of pure distillate using about 20 watts of electrical energy. A single-effect evaporator would require approximately 300 watts for the same yield. The Kleinschmidt compression-distillation process thus has an economy equivalent to some 15 or more effects in a multiple-effect system operating on seawater, and the compression-distillation unit is far simpler to operate than a multiple-

effect unit. Its connections, heat-transfer apparatus, and controls are no more complex than those on a single-effect evaporator. Control is ordinarily effected by adjustment of feed only and shop test units set up for manual control have run day and night for as long as a week without adjustments of any kind.

The basic principles of the process are best understood from the relationship between the heat quantities and temperatures throughout the process as shown in Figure 2. Cold feed entering at 60 degrees, Fahrenheit, is heated (inclined dot-dash line) to 207 degrees by heat exchange with the outgoing condensate and overflow (inclined solid line). Final heating in the evaporator raises the brine from 207 degrees to 213 degrees. The hot feed is vaporized (horizontal dot-dash line) by heat exchange with the condensing compressed steam (horizontal solid line). Clearly, suitable temperature differentials permit exchanges of heat where needed. The temperature differentials are 10 degrees in the heat exchanger and nine degrees in the condenser-evaporator. An excess of heat on the high-temperature side (right-hand end of horizontal solid line) offsets heat loss through the insulation and leaves an operating margin.

The operation is stabilized by allowing excess heat to escape with a small amount of steam discarded to the atmosphere through a breather vent. The total excess heat required for insulation and stabilization losses is about 55 Btu. per pound of distillate. Introducing 68 Btu. into the process at the compressor not only supplies this excess, but also creates the necessary temperature differential. In this manner 960 Btu. are recirculated in the condenser-evaporator and 190 Btu. in the heat exchanger. Thus the 68 Btu. introduced by the compressor circulates a total of 1160 Btu. per pound of distillate, and also supplies surplus heat for operational leeway.

With all-electric drive, the efficiency of the steam compressor need not be high. The amount of energy theoretically required for this compression would be only about 15 Btu. compared with the 68 Btu. practical in moderate-sized units. Actually, 35 Btu. is introduced at the compressor, and 33 Btu. by electric heaters in the evaporation zone.

Economy is somewhat governed by the pressure of the compressed vapor. This relationship, presented in Figure 3, suggests the limitations of the compression principle. These calculations are based on steam, but

could be calculated for other vapors. Compression-distillation units developed thus far have capacities of less than 250 gallons per hour. Insulation losses and allowance for operability are the governing factors in determining the heat input needed. Larger units operating under typical industrial conditions should be more efficient.

USES LESS FUEL—From seawater the Kleinschmidt compression method produces 175 or more pounds of distilled water for each pound of fuel consumed, a ratio three to four times greater than with efficient conventional systems using fuel to generate heat. This low fuel consumption proved of great value to the armed forces during the war. In the Navy, these stills released space normally given to fresh-water storage and, for many types of vessels, extended the cruising range to an extent that was strategically important. Kleinschmidt stills were used by Army and Marine landing parties, particularly in desolate Pacific Islands. On Iwo Jima, for instance, the Marines continuously had fresh water from beach-head compression stills, while the Japanese suffered desperately for water. By the end of the war, enough Kleinschmidt compression-distillation units were in service to produce pure distilled water for the daily needs of over a million men.

The Kleinschmidt distillation system is particularly valuable where waste steam is not available from other process operations. On Diesel and gasoline propelled fishing craft and small cargo vessels, the compression still replaces stored water

and releases valuable space for cargo or fuel, thus increasing cruising range substantially. The Kleinschmidt still gives a definite saving, sometimes of critical importance, by requiring no cooling water. The new process not only gives a product from sea water containing less than one part per million of impurities by a single distillation, but the cost of producing this pure water may be less than 10 cents per hundred gallons.

Although the original objective of the system was to save precious fuel in distant places and on ship-board, this process, like most fundamentally sound processes, has other characteristics which may be of even greater interest than its economy of power. Thus the units are simple to operate, requiring control of only two valves—one for starting and one for control of the rate of feed of raw water. Any Navy engine-room rating can learn the operation in ten minutes. Another rather unexpected advantage is the extreme purity of the product, which, when made directly from sea water, contains less than one-tenth of the impurities allowable under Navy standards for double-distilled battery water. It is also sterile, since all the vapor is heated by compression to over 220 degrees, Fahrenheit.

The industrial possibilities of extremely pure water at low cost are enormous. In the photographic field alone there is a great opportunity for better and cheaper products. Pharmaceutical and other chemical industries, high-pressure steam plants, railroads, sugar refineries, and even textile factories, paper

mills, and laundries in hard-water regions, may soon find compression-distilled water within their reach.

The obvious necessities and urgencies of war have directed development of this important new system toward freshening of seawater. Other possibilities have had to wait. Thus water looms large in all of the industrial uses of compression distillation now planned. Not just the production of pure water but also the removal of water from solutions as in the production of evaporated milk, maple syrup, and similar concentrates. Since the pressures and temperatures involved can be set at any convenient points above or below atmospheric, concentration of biological products and other heat-sensitive materials seems feasible.

Extension of the process to non-aqueous liquids, alcohol, solvents, petroleum, and so on, may be expected to follow commercial development of present fields. Certainly the economy and adaptability of the process suggest it.

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PAPER-MILL SLIME

*Controlled by Use of
Convenient, Packaged Chemical*

HIGHLY soluble and effective as a germicide and fungicide, pyridyl mercuric acetate has been used with success for the control of slime in paper mills. Pyridose, developed by the Mallinckrodt Chemical Company, is packaged in one ounce quantities in paper envelopes.

One package is the usual requirement for the treatment of 5 to 15 tons, dry weight, of paper pulp. One or more envelopes as needed are simply thrown into the beater or other convenient place in the stock preparation equipment. The envelope immediately disintegrates, distributing the treatment material evenly throughout the pulp.

The compounds formed from the substance with the ions common in water are significantly more soluble than the corresponding salts of other organic mercurials. Effective control of fungi and bacteria can increase the efficiency of the operation of paper-making machines, lengthen the life of the paper machine felts, and prevent unsightly blotches on the finished paper caused by contamination. Pyridose can be used to remove slime from an infected system without the necessity of shutting down the mill for cleaning.

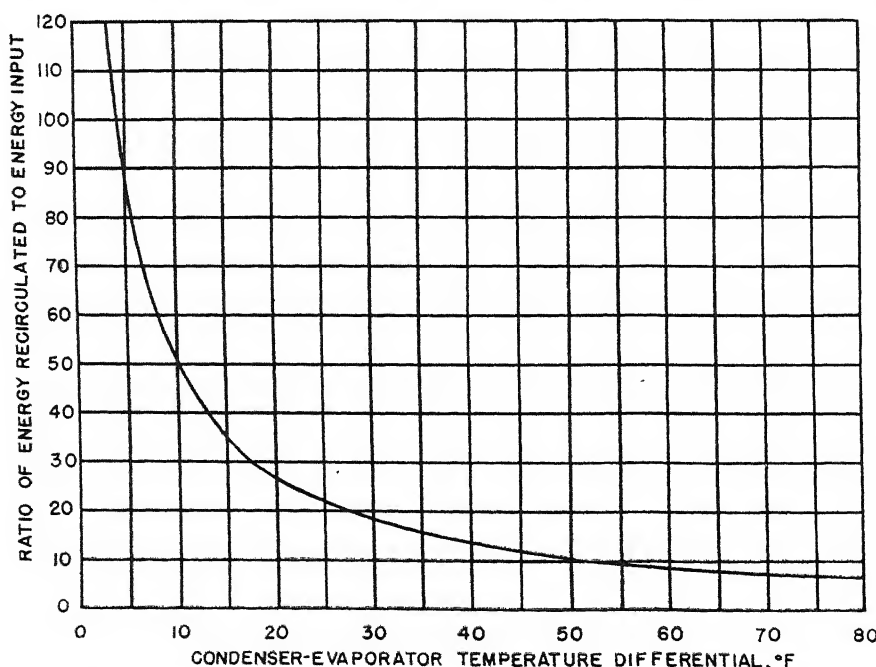
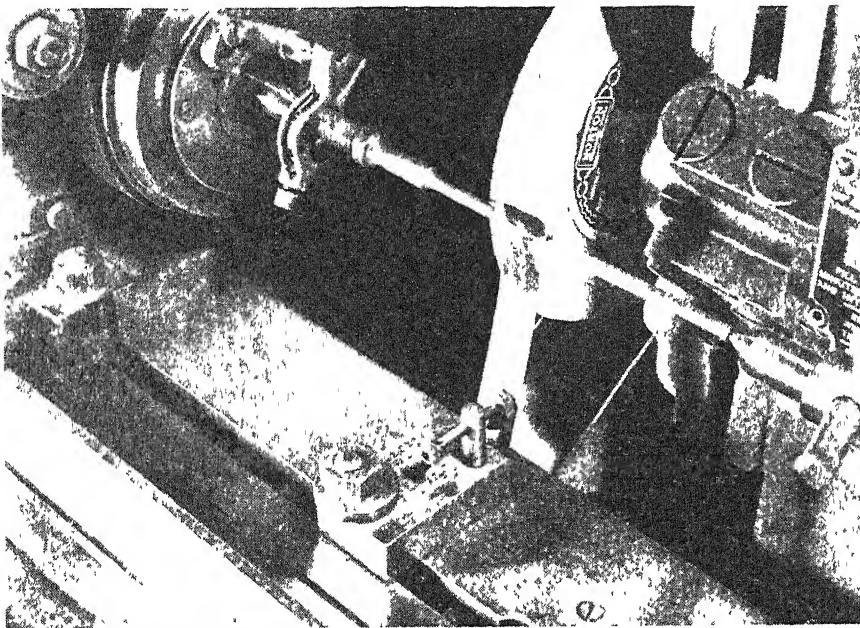


Figure 3. Economy of Kleinschmidt still is governed by compressed-vapor pressure

Departments Without Names

Most Executives in Most Departments of Industrial Organizations are Too Specialized and Too Busy to Obtain a Bird's-Eye View of Their Firm's Integration in the Economic Matrix. Cognizant of These Facts, Many Companies are Establishing Departments—Sometimes of One Man—to Keep an Ear to the Ground and a Keen Eye on the Horizon

By EDWIN LAIRD CADY



Courtesy General Electric Company

Devices too small for any particular department's attention often make large differences in production or costs. Spring-travel grinding rest is an example.

ONE of the world's largest makers of plywood has just hired a mechanical engineer, put him in full charge of a department that probably will never have a name.

Plywood is one of the oldest of engineering materials. The Pharaohs had their artisans make furniture and coffins of it before 1500 B.C. And yet its most ordinary forms were reduced to standards only a few years ago, and some of its most modern glues, wood treatments, and production techniques were new in 1945. The industry as a whole can produce at least three billion square feet a year of the well known spruce or softwood and the standard gum or other hardwood kinds. Hundreds of different combinations of woods, plastics, and glues are made into plywoods suitable for everything

from extremely low-priced packing cases to such completely engineered and higher-cost items as textile-loom shuttles and airplane propellers.

In a situation that has as many possible ramifications as this one it is very easy for a big company to miss some of its best bets or to devote sales and production time to items which do not promise the best return.

CRYSTAL GAZER—It will be the job of the new engineer to watch all of this. He might be called the head of the Who-Ought-To-Do-What - And - When - And - How-Should-He-Do-It Department.

He will report to the president. But before reporting, he will ask a great many questions.

Who has planned the best pre-

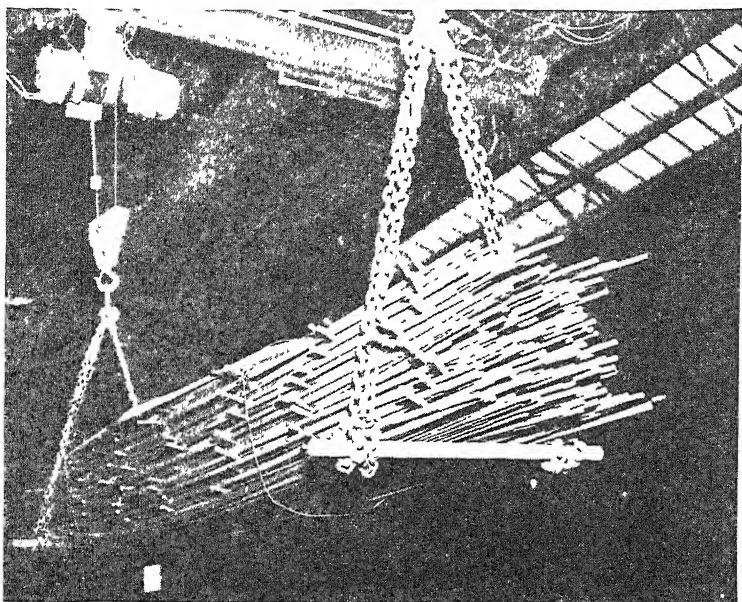
fabricated house and what kinds of plywood would reduce its costs or increase its saleability? Should lumber yards stock standardized houses made largely of plywood, or standardized parts of houses the rest of which can be made of almost anything? Will a brand new plastics glue for plywood veneers permit a greater use of demountable and returnable shipping cases for butchers scales, thus leading to the use of less plywood by some users of shipping cases but to larger ultimate sales by reducing costs and attracting new customers?

He will be going everywhere, talking to everyone. A machinery maker has a brand new veneer cutter which will cut the wood more accurately and smoothly. The more accurate the cutting the more strongly the modern glues will hold. Can the company make more money with veneers cut on these machines? Should smaller, specializing competitors be encouraged to take on the machines, improve their own products, get the bother of some of the smaller but highly specialized markets off the big company's hands?

This engineer gave no permission to quote his name or that of his company lest he be deluged with suggestions and inquiries which ought to go to sales or purchasing or other departments. But in an interview, he said "I must read every trade and business paper I can, be familiar with every kind of industry, meet every research man. There seems to be nothing in industry which my men will not find to be touching the plywood picture somewhere."

LONG-RANGE PLANS — A large foods company took two of its ace public relations men, put them in charge of just such a department several years ago. And the department has paid dividends.

Working closely with these men is every mechanical engineer and chemist in the company. They all have to take long looks into the future. The foods manufacturing busi-



Courtesy Du Pont Company

• LOOKING AHEAD •

Technically, economically, politically—fewer business “bumbles”. . . Less confusion within companies on “policy” and planning. . . Keener executive appreciation of the interdependence of producers, users, even educators. . . Advertising that says more, means more.

ness is changing all the time and almost always for the better.

There is, for example, the matter of vitamins. Vitamins can be synthesized and added to foods in the processing plants. But some of the best forms of them are best added by growing them right into the raw foods on the farms. And this often means that the farmers must use vitamin-bearing fertilizers, chemical combinations that all too seldom are put into the soil.

Does an adequate college text book exist on the subject of “getting more vitamins into the crops?” If not, this department must talk with professors in the better agricultural colleges, make contacts with technical-book publishing houses, get such a book written and published.

Many a food-value question is going unanswered because there are no specially trained scientists who have the time to find the answers. This department goes to the colleges, sets up scholarship and other funds, gets brilliant young science students to study specific problems. There will be a job waiting for every one of these students when he finishes his studies. Perhaps that job will be with this company, perhaps with a competitor, perhaps in a university, or with a government department.

Modern methods of de-scaling steel were once only dreams in departments without names

These nameless departments of business have to take it for granted that hundreds of other business and professional institutions will benefit by their work just as thousands of smaller makers of similar products get free rides on the advertising of the larger companies

This department keeps in constant touch with developing laws in the national and state capitols, has long and serious talks with legislators. Bigger public health budgets mean higher sales of the better and costlier foods products. A law which suggests or requires changes in food processing methods may mean big changes in foods factories right now, even bigger ones to take place gradually over a period of years.

The mechanical engineers must be ready with the plans for new machinery and equipment to take advantage of or to comply with a new law long before that law is formally entered on the statute books. The engineers have to know, too, what the new research is likely to bring out, what production plans they must make. Otherwise, the fulfillment of an opportunity to make and sell more and better foods would be a slow process.

“BRINGING UP” A PROCESS—One of the largest strip-steel and wire-products makers has an engineer in charge of a department so nameless that he does not even know to whom he is supposed to report his activities. He just reports to anybody in the company, brass hat or assistant

Below: Movies at 2500 frames per second yield data for unnamed departments. Product performance, new fabrication techniques, knowledge of users’ problems and competitors’ activities, are often bits of industrial intelligence that form a basis for the reports from these departments



Courtesy Western Electric Company

foreman, who might be interested in something the department is doing.

The research department brought out a new welding technique which would permit stronger than usual joining of thin, stainless-steel materials. After making sure that the process would work on a commercial scale, this engineer and his assistants began to ask questions of prospective users.

Who needed stronger welds in thin, stainless-steel products, and at what costs, and with what production speeds? They asked the product designers of automobile and airplane companies. They went to the makers of building materials, to the National Bureau of Standards, to the National Housing Authority. They sent researchers to local hardware stores to see what complaints the consumers were making about present products. They studied mail-order catalogs and advertising pages of magazines, talked with makers of thin-materials forming machinery to see if the new product might make differences in production speeds or bring about new machine designs, did everything to get more and more ideas.

Their story would have been very nice if it had turned out that the process was perfect and that an enormous market awaited its products. But there were problems. The process was a little too slow. Worse still, it was not flexible enough, it would not work equally well with all of the variations of carbon con-

tent and metals ratios which steel makers are permitted by existing standards to put into a single grade of stainless steel. It needed highly expensive, rarely obtainable special steel grades to do its best work.

Any company which did not have one of these nameless departments would almost certainly have had to abandon the project, write off its development costs, give up hopes for its profits. But this engineer and his department were just starting.

First of all they walled off a special department in one of the company's buildings, got the process set up, started making products on it. These products often were sold at a loss. But from every one of them something new was learned.

This went on for three years. In the meantime the engineer went to a local engineering school, signed a large check in behalf of the company to set up a fellowship, got a professor to work on the equipment and its problems, persuaded several engineering students to work on it as part of their studies.

One by one the kinks were ironed out, the process was applied to new and more profitable uses, the markets developed. As fast as the engineering students who worked on it in school were graduated they found good jobs waiting for them, either as operators of the process or as application engineers to get it into operation in the plants of customers of the company.

BENEFITS WIDESPREAD—A maker of abrasives has a department within the nameless department to study all new processes and developments which might affect the making or the using of the company's products.

These men may recommend that the company buy up a new material or mechanism, or buy some of the rights to it, or buy out the company that developed it so as to get the engineering man-power as well as the sales and physical assets behind the product.

More often, they go to work for the product developer without charging him a cent for their efforts and even, in some cases, without telling him what they are doing. They go to the research laboratories of universities and to consulting laboratories, spend company money to have the applications and possible improvements of the products studied. If the new product can increase or otherwise affect the sales of their own products they issue bulletins on it to their sales engineers, suggest its purchase to customers, arrange for mill supply houses to stock it.

What they learn from the univer-

sities and the consulting laboratories cannot always be taken direct to the product maker lest he suspect that a big company, perhaps big competitor, is interfering in his business. But a quiet hint to a user of the product to ask for certain improvements, or any of a dozen other roundabout methods usually will get the desired results.

As a result of this work the company almost always is ready with new products before the changes in its markets occur, and always is a leader in new technical developments for its own production line.

MEN ALSO STUDIED—The treasurer of one of the largest makers of alloys is the head of an unnamed department. He studies men rather than products and techniques.

Every time the company hires an exceptional student from a college, and whenever someone already on the payroll shows signs of imagination, this treasurer runs a personal file on that man. He learns what the man is thinking about, what he likes to do, has personal interviews with him, studies his work and his progress in the company.

Sooner or later the treasurer finds a new development which the man is capable of handling. The man is put in full charge, told to work with the company engineers and other authorities, but to build that new development if he can. He is given a budget plan which may cover five or more years ahead. The men so developed have made the company such a leader in its field that government authorities want to break it up, yet never once has this selecting and building of men been made a formal policy under a department with a name.

These nameless departments are everywhere in industry. No two of them are exactly alike, excepting that all seem to be preservative and constructive to industry as a whole as well as profitable to the companies that have them.



"BUTTER-LAYERS"

*Once Weakeners of Parts,
Yield to "Super-Finishing"*

ANY STEEL is a mechanical mixture of extremely fine particles or grains variously bound together. Some of the grains are hard and brittle, some are hard and not brittle, some are soft and brittle, some soft and malleable.

The malleable grains can cause trouble. Cutting tools, whether they

be the steel tools used in cutting or the abrasive grits of grinding, will break off the brittle particles and push aside the grains which are hard but not brittle. But the malleable grains have a tendency to stretch under the tool pressures and be spread like butter across the finished surfaces.

In extreme cases, such as permitting lathe tools to "ride the work," this "butter-layer" can appear like a burnishing job with the work becoming as much as .003 inch oversize. In fine grinding, this buttering effect can produce a surface which measures accurately under the micrometer but shows a roughness as great as 20 micro-inches under the Brush Surface Analyzer.

Also, the butter-layer is a false finish prone to sluff off in bearing metals and shorten the lives of bearings, to abrade mating surfaces, to be an easy point of corrosion attack, and to provide areas at which stresses may concentrate to cause abrupt failures of parts.

Modern super-finishing methods, done with specially contoured abrasive stones, eliminate this false layer and greatly increase the dependabilities of machine parts.

AIRCRAFT TECHNIQUES

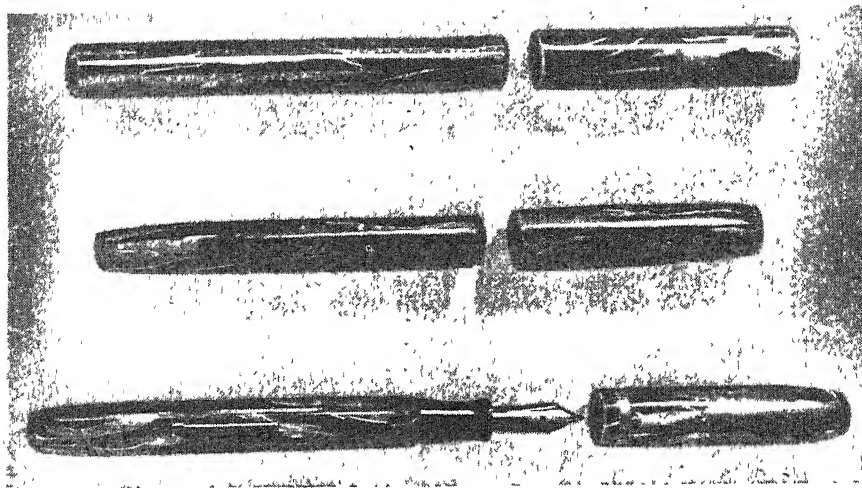
*Adapted and Modified
for Many Other Industries*

INDUSTRY-in-general always seems to have some one division which works out the materials specifications and the production techniques for everybody. Up to about 1914, the railroad shops were the fountain heads of all wisdom, then the automobile industry took over, and now the aviation industry is beginning to show the way.

The main difference between automotive and aviation production is that aviation has to work with structures of lighter weight, with larger dimensions, and has to make changes in designs far more frequently.

Truck bodies are now made of high-tensile, corrosion-resistant steel tubing and structural shapes which are so cross-braced and steel sheathed that every ounce and inch of metal bears its full share of the stresses and no metal "rides for free." Such bodies are light in weight, can carry more payload, are long lived, and easily maintained. The technique for making and designing them was borrowed almost entirely from airplane experience.

Similar gains are being made in railroad cars, boats, pre-fabricated houses, and industrial materials-handling equipment.



Plastics tubing to fountain pen in three steps: Cap and barrel cut to length, ends formed and threaded; working parts installed. Technique is vital factor

PLASTICS

Layer-Cake Plastics

Not Always Made as Simply as Their Appearance and Applications Might Suggest, Plastics Products—Fountain Pens, for Example—Frequently Undergo a Number of Carefully Planned Fabrication Stages

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

IN A MATERIALS field where both color and eye-appeal are the rule, "laid-up" plastics rank near the top on both scores. Pearl-like panel effects, simulated wood grains, grained ivories, and other attractive patterns are only a few of the possibilities of the roll-lamination or hand-lay-up methods. Applications range from protective covers for golf-club shafts to decorative and useful domestic equipment and fountain pens. As an example of the process used to attain these beautiful and variegated plastics articles, the familiar fountain pen serves admirably.

The cellulose nitrate unit represents an estimated 90 percent of the fountain-pen market. Its production is a painstaking operation requiring skill, technical knowledge, and a flair for color and design. The patterns used are varied, and the processes used to produce them are, of course, also varied to some extent. The type using a series of pearled cellulose nitrate panels $\frac{1}{8}$ inch wide and separated by plain colored or transparent strips of the

same material may, however, be considered as fairly typical.*

PEARL ESSENCE—The first step in the manufacture of pens of this type, and all other types, is the mixing of the material. Pearl essence, a substance obtained from herring scales, comes in tiny flat crystals, the largest being less than 0.003 inch long. Suspended in a suitable carrier, such as cellulose-nitrate lacquer, the pearl essence is mixed with camphor as a plasticizer, tinting dyes, cellulose-nitrate flake, and alcohol as a solvent. As a general rule each batch of material weighs approximately 250 pounds as it goes into the large mixer whose action insures complete intermingling of all the components.

Since the slightest foreign matter of any type can ruin a quantity of pen bodies and caps, the pearl-essence compound is carefully filtered before further work is done on it. The equipment used in this operation is similar to a large hydraulic

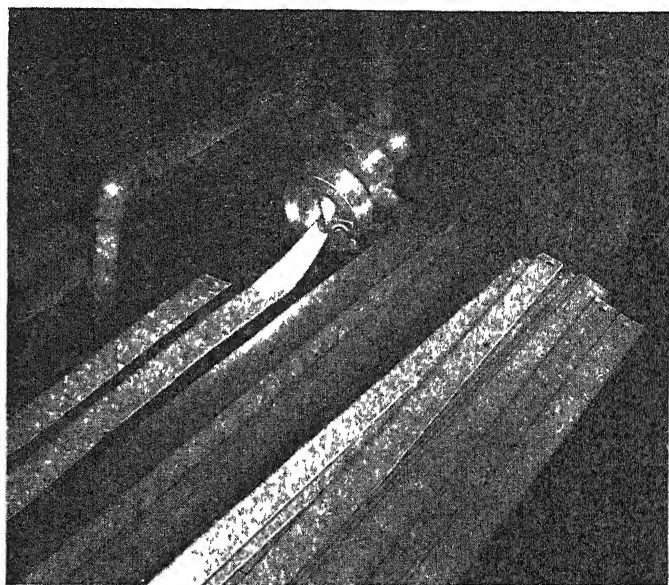
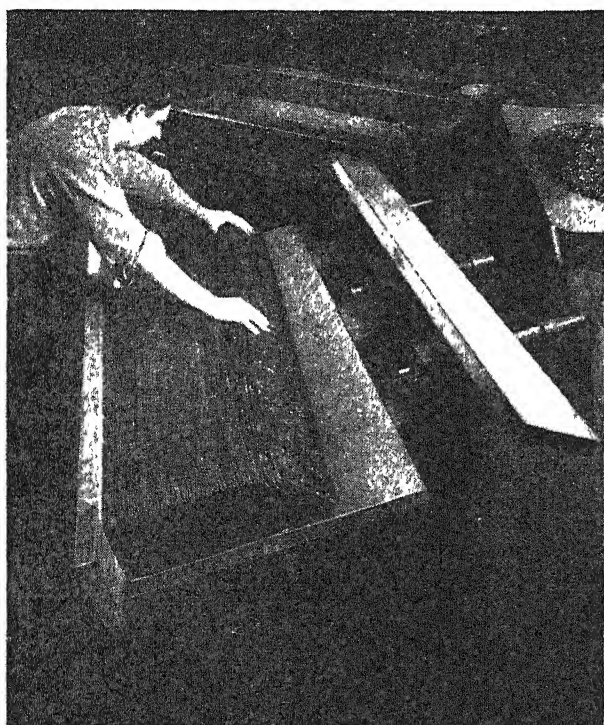
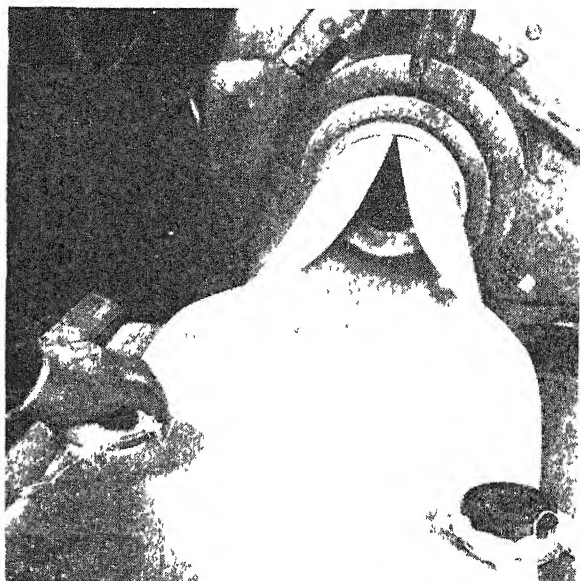
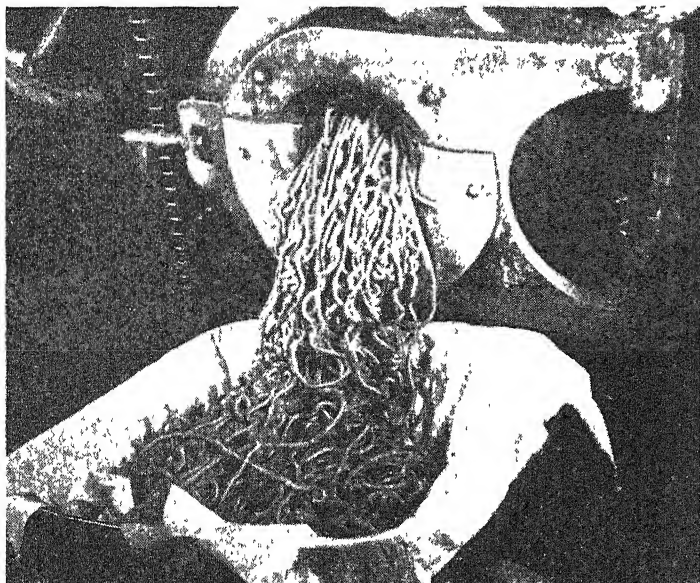
*Nixon C/N is the cellulose nitrate used in the plant described and pictured in this article

• LOOKING AHEAD •

Striking patterns of "laid-up" plastics adapted to a growing variety of articles. . . . Endless possibilities of designs and combinations with other materials. . . . Machinability of patterned plastics will attract attention of manufacturers seeking appearance coupled with fabricating flexibility.

extruding machine. In it, a filter disk of muslin is backed up on one side by several screens, each of a different mesh. These screens, in turn, are backed by a plate perforated by $\frac{1}{4}$ inch holes spaced about $\frac{1}{2}$ apart.

When the material is placed in the cylinder of the filter, a hydraulic plunger forces it slowly through the filtering muslin and screens and then through the perforated back plate so that the plastics emerges in the form of spaghetti. To convert the material to a form in which it can be managed by the extruder, this so-called spaghetti is divided into 60- to 70-pound lots and pressed into a tubular container. Weighed down on top over a long period of time, the material loses its string-like appearance and becomes a homogeneous mass. This is possible because of the solvent re-



Colorful pen-plastics stem from multiple-step process: pearl-essence compound is filtered (upper left) through "spaghetti" extruder; extruded again (upper right) and split into sheets for "layer caking" (lower left); pearl essence thus oriented, pen tubing is drawn (lower right)

maintaining in the material which keeps it in a soft state.

The plastics as it is removed from this tubular form and taken to the extruder is known as a "jelly roll." The roll is of the exact size and shape to fit into the chamber of the extruder—the latter being quite similar to the filter used in the previous operation.

The cellulose-nitrate tube extruded by this machine is generally about six inches in diameter and has a relatively thin wall section. Just as it emerges from the die which has formed it into the tubular shape, the material is slit along the upper side so that it flattens into a sheet.

This extrusion operation is the beginning of an involved process that spells the success or failure of

the production of high-luster pearl effect. As the plastics mixture is forced through the narrow annulus of the extruder, the minute pearl-essence particles are forced to align themselves in the direction of the extrusion. Thus they present the maximum amount of luster at the surface of the sheet. If the pearl essence were not oriented in this manner the extruded sheet would be relatively lusterless.

LAYER TECHNIQUE—But this is only the beginning of the desired pearl-essence effect. Depending on whether a ribbon or mottled effect is desired, the flattened cellulose-nitrate sheet is cut into strips or into large chips. These strips or chips are then placed flat in a cake-press form measuring 23 by 56

inches and built up to a depth of five inches. Under heat, and pressure exceeding one ton per square inch, the pieces of plastics become a solid homogeneous mass, called a cake.

Sheets of material $\frac{1}{8}$ inch thick are sheared from the top of this cake and cut into five-inch wide strips. Then the material is once again laid-up in the cake press, but this time the strips are placed on edge rather than flat. As a result of the laying-up of the strips in this manner the cake, when it is again formed under heat and pressure, has the luster of the pearl essence oriented toward the side rather than toward the top.

Again the cake is sheared into sheets which, at this phase of manufacture, have very little surface lus-

ter because of the deliberate side orientation of the pearl essence in the last operation. When the sheets are again cut into strips and placed on edge in the cake press form, however, the luster is brought to the top where it appears in the final cake.

It is in this final lay-up that the pattern of the pen body and cap is determined. Instead of being made up entirely of strips of pearlized cellulose nitrate, the pattern may call for the insertion of various colored plastics strips between the pearl strips, or of transparent cellulose-nitrate strips if the design is for a pen utilizing the visible ink supply principle. Whatever the design, this last lay-up operation is followed by another caking cycle and the slicing of the cake into sheets approximately 0.050 inch thick.

TUBE FORMING — Before these sheets can be made into tubes they must be seasoned so they will not warp when finally made into pens. This operation, in which all the remaining solvent is removed, is accomplished by placing the sheets on racks in rooms held at a temperature of about 110 degrees, Fahrenheit. Since the plastics tends to curl slightly during this treatment, the sheets are placed between high-luster plates and subjected to a relatively high pressure in a hydraulic press.

Cut into strips 1½ inches wide and 50 inches long, the material is ready for tube forming, which can be done either by butt-welding or by spiral-welding. In both cases, the strips are first placed in hot water to soften them, then pulled through a forming die which causes them to take the shape of a tube.

For the butt-welded type of pen case, a steel mandrel is placed within a die having a diameter equal to the desired outside diameter of the finished tube. Once the cellulose nitrate is softened it is hooked at one end to the front of the mandrel which is, in turn, attached to a moving chain. As the chain pulls the mandrel through the die, the plastics strip is drawn into the funnel-shaped mouth of the die which starts the forming of the strip so that it will wrap around the mandrel. When the material reaches the final forming section of the die, which is chilled, it sets in the form of a tube with the edges of the joint pressed tightly together. The joint is not yet welded, however.

The only difference between the production of the butt-welded and the spiral-type tube lies in the fact that with this last type the mandrel

revolves as it pulls the material through the die.

The one prerequisite of a good seal is the careful separation of the edges of the joint to permit the solvent, in which the tube is placed, to come in contact with them. A hooked knife run down the entire length of the joint in a butt-welded tube effectively separates the edges, while a slight twist of a spiral-type tube in the direction opposite from that of the spiral opens the joint enough to allow the entrance of the solvent. Once the hooked knife is withdrawn or the spiral tube relieved of pressure the joint will seal without the addition of pressure. After an aging period of approximately three weeks to allow for the evaporation of all solvent absorbed during the welding operation, the pearl-paneled, cellulose-nitrate tubing is ready for the finishing operations that insure the proper functioning of the fountain pen.

TUBES INTO PENS—No matter how carefully the cellulose-nitrate tube is formed, it still lacks the necessary accuracy on its inside diameter. To bring the tubes to size they are placed in hot water where they become soft and pliable; then over a steel mandrel ground to a size corresponding to that specified for the inside of the fountain-pen body. Next the tube and mandrel are placed in a chilling bath of cold water and the mandrel removed as soon as the plastics hardens. Finally, a centerless grinder is put to work on the tubing to give the desired outside diameter. And with that the work of the cellulose-nitrate fabricator comes to an end.

There still remain a number of operations which the pen manufacturer must complete before the fountain pen is complete. First, the tubes are cut to length, threaded, and otherwise machined, using standard machining methods. To close the bottom of the pen barrel and the top of the cap, shaped and formed plugs are inserted in the tube openings and welded in position.

This closing operation can also be done in a number of other ways. The one most generally used for the older types of pens simply involves the welding of a flat top over the end of the tube. When shaped ends are employed, these can be turned out either by molding or by a forming operation in which a disk of heated nitrate is forced into a die and then molded to the desired shape. Another, and perhaps the most successful, method of closing off the end of the plastics tubing involves softening the cellulose nitrate and forcing the end section in-

to a warm die which molds the material into a point—producing a one-piece cap or barrel.

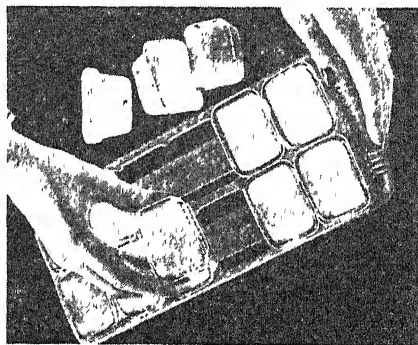
Thus emerges a completed fountain pen. Some of the steps in its production are specialized, but the steps involving the compounding and manufacture of the basic material are indicative of the thought and planning that are so vital to the successful manufacture of any plastics article.

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ICE-CUBE TRAY

*Retains Flexibility at
Refrigerator Temperatures*

ADDED to the list of improvements upon the venerable ice-cube tray is the Jiffy-Cube which comprises 12 compartments formed of ethyl cellulose sheet. The advantage of this material is that it remains flexible at low temperatures and does not



Ice does not adhere to cups

adhere to the ice. Consequently, ice cubes may be removed from the compartments, each in a separate container of its own, simply by pressing a dimple on the bottom of the cup. Both production and assembly of the ice-cube maker is done by Standard Products Company for Plastray Corporation.

EXCAVATOR WINDOW

*Made of Plastics to
Resist Vibration, Impact*

REMINISCENT of the Plexiglas bomber noses and gun turrets that are standard equipment on so many military planes is the cab window on the Byers Machine Company's dirt shovel. This window, which has been found easy to install, is as transparent as glass and, unaffected by vibration, may be the forerunner of many more industrial uses of a similar nature for this plastics. Especially important in this particular application is the ability of Plexiglas to withstand heavy impact blows.

Cabins Can Be Quieter

Airline and Private Plane Manufacturers—More "Customer-Conscious" Than Ever Before—Are Striving Vigorously to Improve Cabin Comfort

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

AS AIRCRAFT engine powers and airplane speeds increase, the need for noise reduction becomes ever more apparent. Here there are, in reality, two noise problems—one involving the protection of the plane's passengers against propeller and engine noise, and the other being the necessity for reducing the external noise of the plane so that it ceases to be a nuisance to the general public. This article confines itself to a discussion of noise reduction within the plane itself, leaving the second phase of the problem for future discussion.

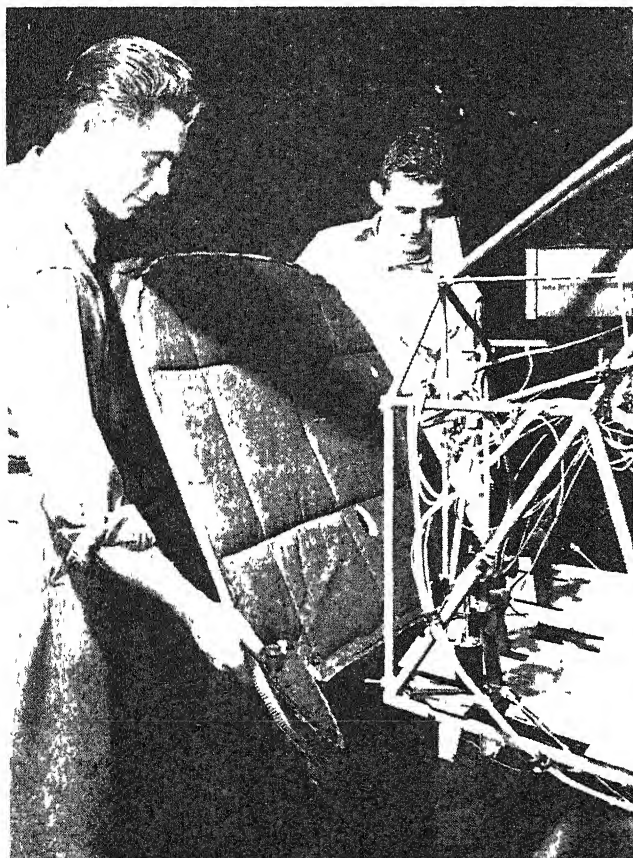
The sensation of sound is produced by alternating air pressures in the sonic range. But the measurement of these varying pressures is not a guide to loudness. The

change of sound intensity, as the human ear feels it, is proportional to the fractional increment, rather than the absolute increment. Hence, the preception of sound increases far less rapidly than the pressure.

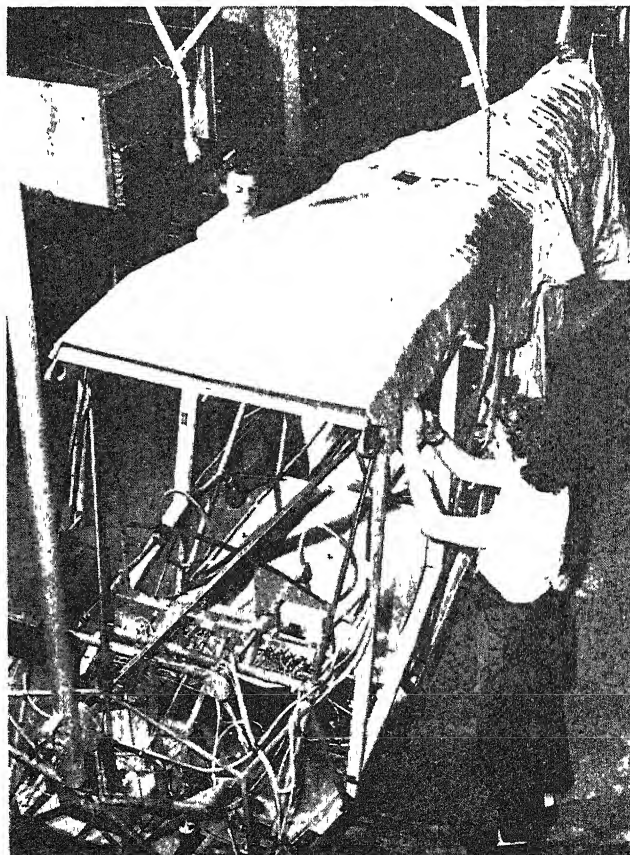
LOGARITHMIC SOUND—For this reason, sound intensity is measured on a logarithmic scale rather than an arithmetical one. The decibel is ten times the logarithm of the ratio of sound intensity to the intensity existing when the ear can barely

hear anything—the threshold of audibility. Accordingly, a ten-fold change in intensity only adds 10 decibels, or ten times the log of 10, which is one. It is this curious mathematical concept that explains many of the difficulties of sound measurement and noise reduction.

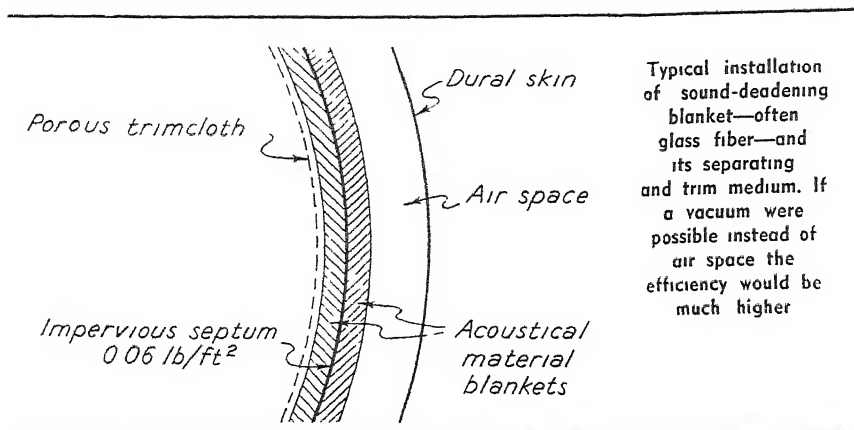
Furthermore, overall intensity or loudness is not a satisfactory indication of comfort or discomfort. The sensation varies with the frequency. A high-pitched noise of the same loudness as a low-pitched noise will



Only one inch thick, sound-absorbing fire-wall blanket will insulate engine noise and heat. It is also non-combustible



Sound-proofing light airplanes reflects new attitude on part of private flyers. Stinson "Voyager" has "airliner" comfort



• **LOOKING AHEAD** •
 Airplanes more silent, eventually, than older forms of transportation . . . Application of aircraft sound-proofing methods to automobiles, homes, industrial structures. . . Much wider acceptance of private aviation when quieter cabins become universal.

produce considerably more annoyance. Therefore, in addition to knowing overall sound levels, it is important to be able to measure the intensities of various frequencies in a noise containing a wide range of frequencies. Measurements taken on this basis indicate that noises may be much less distressing when the higher frequencies are suppressed—even if overall loudness is only slightly decreased

In aircraft applications, a coarse analysis of the various frequencies present is sufficient. Here, the range of audible frequencies is divided into band widths of one octave, and the range from a very low 40 cycles per second to a shrill scream of 10,000 cycles per second can be covered in eight bands. Thus, noise levels may be defined in terms of decibels in a given frequency band and an entire technique has been developed for the measurement and analysis of aircraft cabin sounds. Considerable special equipment, including artificial means for producing pure sounds of varying frequencies and intensities, standard microphones, amplifiers, decibel indicators, wave filters, completely noiseless chambers, and so on, have been evolved and in some cases are being applied in other industries

HIGH FREQUENCIES WORST—The permissible levels for noise in different types of aircraft must, of course, be established before manufacturers can enter upon sound-proofing programs in an effective manner. In a paper read before the

Royal Aeronautical Society by Dr. N. Fleming, permissible sound levels for military, cargo, and civilian passenger airplanes were tentatively set forth. These recommended levels vary from 105 decibels in the 75 to 150 frequency range to 80 decibels in the 1200 to 2400 frequency range for military and cargo planes. For passenger transport, the comfort levels are reduced ten decibels at the lower frequencies and 15 decibels at the higher frequencies.

Examination of typical sound values as encountered under familiar circumstances will provide a concrete idea of what decibel levels mean. For example, a passenger car moving at 30 miles per hour measures 60 to 70 decibels; an air-conditioned railroad coach shows 85 decibels at 50 miles per hour; a trolley car registers 90 decibels; the New York subway may go to 120 or even more.

It is interesting to compare these figures with noise measurements (Table 1) made in the well-known DC-3 twin-engine airliner while the plane was flying at 160 miles per hour with the engines delivering 600 horsepower at 1850 revolutions per minute, and with a propeller tip speed of 740 feet per second.

It will be noted that the data presented cover one low-pitch band and one high-pitch band, thereby giving a truer indication of comfort than would single-level readings. The multi-level method has now become standard as the result of research at the Harvard Electro-Acoustical Laboratory. In both frequency ranges, the aft-center cabin of the DC-3 satisfies the previous recommendations as set up by Dr.

Fleming. The forward-center cabin, however, particularly in the less annoying lower octave and to a small degree in the higher octave, does have noise levels above the recommended figures, regardless of the fact that the plane is generally considered satisfactory by most passengers.

Once the characteristics of cabin noises are established, the physical problem of reducing these noises usually embraces a plan of insulating those of external origin—engine exhaust, propeller sounds, and aerodynamic sounds. Also, internal noises due to electrical motors, pumps, gears, and the moving parts of the air-conditioning machinery cannot be neglected.

INSULATION "KNOW-HOW" — For successful sound insulation, it is important to avoid all cracks and openings in the insulating structure. The smallest cracks may nullify the best sound-proofing treatment. Apparently sound entering through a narrow aperture can produce almost the same sensation of loudness as an open window. Sealed openings around hatches, doors, windows, and ventilators, must be in good condition. As much of the area of the airplane structure as possible should receive acoustical treatment and the areas of untreated metal surface must be held to a minimum.

One successful sound-insulating method employs two blankets of sound-absorbing material separated by an impervious septum. The thickness of the two blankets may be as low as 3/4 inch, and the treatment is so effective that the minimum weight is only .15 pounds per square foot, excluding the weight of the trim cloth, septum, and muslin container.

The sound-proofing material used in such blankets before the war was generally flame-proofed kapok batting. Later, when kapok was no longer available, a number of materials including pure milkweed floss were tried with varying degrees of success. Glass fiber finally won out because it is the most effective for a given weight of material, because it is not susceptible to attack by mildew and fungi, and because it is non-combustible.

Fundamental to the sound-insu-

Position	Overall Level	Decibel Level	Decibel Level
		75-150 Frequency Range	1200-2400 Frequency Range
Pilot's Position	111	104	75
Forward-Center Cabin	110	106	66
Aft-Center Cabin	98	92	62

Table 1: Noise levels in a DC-3 at 160 miles per hour

lating idea is that the acoustical material should have as large an area of fibers as possible in proportion to its weight. Fiberglas "A" meets this requirement splendidly since it is made from thousands of glass fibers only a micron—1/1000 of a millimeter—in diameter. The glass fibers are coated with a plastic binder to produce a bronze-colored blanket which is ordinarily about half an inch thick and weighs only 1/40 pound per square foot.

NOT ONLY AIRLINERS — Sound-proofing need not be restricted to large transport airplanes. Private airplanes can be equally quiet, and the day when the private flyer "enjoyed" the full impact of propeller and engine noise is gone forever. The purchaser of a private airplane is coming to demand and obtain the greatest interior comfort, with cabin sound-insulation a "must" feature.

The Stinson Voyager 150, for example, is a private plane which has proved as quiet as most transports and in which almost identical glass-blanket methods of protection have been followed. During the manufacture of this plane, the sound-absorbing blankets are cut to size

and shape and lightly attached to the superstructure. Skin and trim fabrics are then pulled over the blankets.

In large transports, the sound-proofing might be carried still further if, instead of placing the insulation about three inches from the dural wall of the plane as is done today, a vacuum was used as insulation in a manner somewhat similar to a thermos bottle. Structural engineers, however, advise that in the light of present knowledge the weight of such construction would be prohibitive.

The sound-proofing of aircraft offers many opportunities for the manufacturers of plastics materials, for instrument builders, for physicists. Its principles are applicable in numerous other structures and industries even though the actual materials and methods may differ. In an expensive building, for example, an adequate thickness of wall may obviate the need for additional sound-insulating material, yet in a low-cost pre-fabricated home, a thinner, less expensive wall might be quite satisfactory if it included acoustical material which also insulated against heat and cold. Truly, there are some fascinating prospects.



FLYING WING

*Carries Heavy Load
at Unusual Speeds*

MINIMUM air drag resulting from the elimination of the conventional fuselage is reported to give the new Northrup Flying Wing — XB-35 — a speed 100 miles per hour greater than could be obtained from an ordinary type plane of equivalent power and capacity. Submerged within the wing structure itself are four Pratt and Whitney Wasp Major engines of 3000 horsepower each. The submerged mounting offers a considerable reduction in frontal area and makes major breaks in the airfoil contours unnecessary. In addition, eight propellers of the pusher type are used and are co-axially mounted — two per engine — with the engine drive gearing so arranged as to drive them in opposite directions. The latter feature allows each propeller to cancel the torque effect of its mate.

Crew accommodations consist of a long, narrow, pressurized nacelle equipped with a bubble-type canopy.

Control of the Flying Wing has been achieved without the usual tail surfaces. Landing flaps are provided in the normal manner and are supplemented by wing-tip slots to pre-

vent tip stalls. Outboard on the wing are the so-called "elevons" which control longitudinal stability much as do conventional elevators but which have an additional aileron-like function when necessary.

Double, split flaps — opening like a clam shell — are located with a hinge line aft of the elevon hinge line and increase drag on one side or the other as needed for directional control.

The Flying Wing, representing 23

years of research, has a span of 172 feet, a wing area of 4000 square feet, an empty weight of 73,000 pounds, and a surprising useful load of 120,000 pounds.

PLANE COMFORT QUIZ

*Indicates that Planes
Could be Still Better*

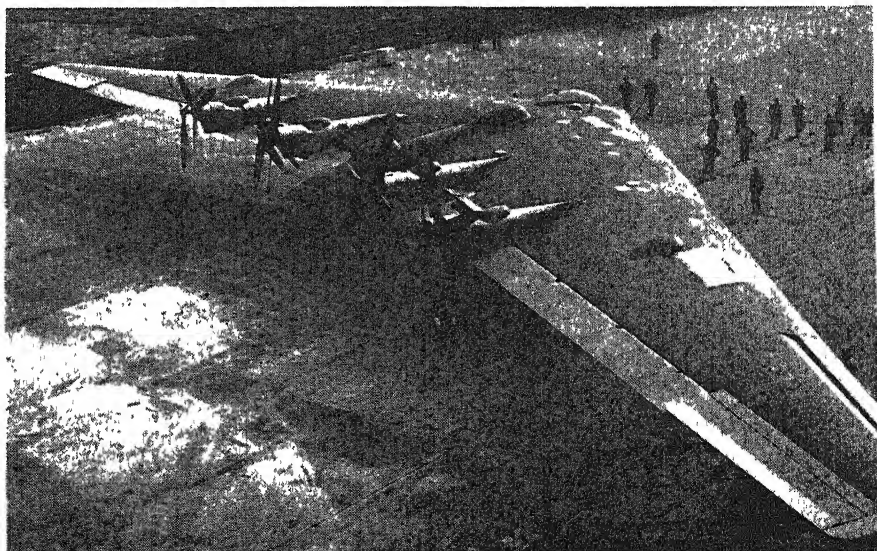
NOW THAT airplane travel has become as inexpensive as railway transportation, and is very much faster, it is fair to compare the two as regards comfort. Hence, the *Boeing Magazine* has made an opinion survey.

Asked which is less comfortable, a train or a plane trip, 50 percent of those queried answered "train"; 20 percent said the airplane was less comfortable, 11 percent said they were about the same; and 19 percent didn't know. Apparently the airplane had somewhat the better of it in this quiz, but it is not to be concluded that the airplane is above improvement in comfort.

Travelers by air, whether experienced or newcomers, often complain of lack of space to move around; roughness, bumps, and sinking feelings; air sickness; lack of berths, noise or vibration; and fear causing discomfort.

Some of these complaints seem likely to be removed by modern aircraft designs. Fear will be dispelled by still greater improvements in safety. Greater size of aircraft with separate dining quarters and lounge halls can remove the criticism of lack of space. Very fast, heavily loaded aircraft, flying at great heights, should avoid bumpy sensations and hence help to reduce airsickness.

Lack of berths is a question of economics—if the public is willing to pay more for air travel, berths will be forthcoming.



Three-quarter rear view of the latest Northrup Flying Wing

Multi-Purpose Paradox

Until All Machines Use Similar Bearings Under Like Load Conditions, "All-Purpose" Greases Remain Impractical. Multi-Purpose Greases are Available, However, and When Common Sense Indicates Their Use They Can Save Time, Reduce Inventories, and Eliminate Confusion

By T. G. ROEHNER

Technical Director, Technical Service Laboratories,
Socony-Vacuum Oil Company, Inc

RECENT years have seen a greatly accelerated rate of development in the lubricating-grease field. Experience under service conditions forcibly demonstrated the need for greases capable of operating under extremely wide ranges of temperatures. Many aircraft bearings for example, may during the course of a single flight be exposed to temperatures as low as minus 65 degrees, Fahrenheit, at altitudes over 35,000 feet and as high as 200 degrees at low altitudes.

Conventional greases having the consistency of butter at room temperature may become so solid at sub-zero temperatures that movement of bearings packed with them can not be started even by application of pressures sufficient to twist light shafting. The use of a grease such as that commonly employed for the lubrication of ball bearings in electric motors would mean that at high altitudes trim-control tabs could not be operated nor could the cowl flaps and many other components of aircraft be actuated hydraulically.

Farm machinery shipped from Detroit might be used in the tropics or be exposed to winter conditions in Russia. The greases in tractor wheels have to resist the temperatures encountered, prevent entrance of dirt and sand, and protect the bearings from corrosion in wet areas.

Greases used on ship-deck machinery must perform satisfactorily both during winter storms and during summer trips around Cape Horn to India. Furthermore these greases have to stay put and serve as rust preventives when the machinery is submerged by heavy seas.

Superimposed on such varied performance problems as these, is the

• LOOKING AHEAD •

Greater co-operation among machine designers, bearing builders, grease compounders. . . Further development of multi-purpose lubricants for non-mobile equipment. . . Grease application devices with wider adaptability. . . More about water- and high-temperature-resistant greases.

steady demand for reduction in the number of greases required to satisfy all operating requirements. At the start of World War II, for example, a survey showed that if the instructions of the manufacturers of ordnance equipment were followed rigidly, over 30 different greases would have to be supplied on practically a world-wide basis. Before V-E Day, this unwieldy number was reduced to four basic and about six special greases.

The ideal, of course, would be the improvement of greases and their applications to the point where a single grease could lubricate all bearings, winter and summer, regardless of severity of operating conditions. Such "all-purpose" products have not been achieved. Progress, however, has been made in developing "multi-purpose" greases.

GREASE KNOWLEDGE NEEDED—

New types of products have recently been developed, such as those made with lithium, strontium, barium, and high-melting-point calcium-base greases. These new greases possess water- and high-tempera-

ture-resistance features not found in conventional calcium-, sodium-, and aluminum-base greases. Advances have also been made in the formulation and manufacture of the latter.

Of equal, and perhaps greater importance is the recent progress in the methods for evaluating greases and securing more accurate interpretation of test data. This research led to a better understanding of the fact that all greases undergo critical changes in structure and consistency as temperatures change.

A sodium-base grease, for example, may have the consistency and structure of a conventional, auto-wheel-bearing grease at room temperature, but at sub-zero temperatures it may change to a product so hard that a pencil can be forced into it only with considerable difficulty, while at about 200 degrees, Fahrenheit, it may be converted to a soft, tough-fibered grease that will wind around a spindle, and when raised to 300 degrees, Fahrenheit, it may acquire the appearance of a jelly.

Greases may be quickly defined as soap-thickened mineral oils and an understanding of the fundamental differences in their behavior in service as compared with uncompounded lubricating oils—which remain as true fluids above their pour points—is valuable to those concerned with grease usage. This is particularly true with the more recently developed greases which may contain, in addition to soaps, components to improve their chemical and structure stabilities, to increase their rust-preventive properties, and to add to their load-carrying abilities.

Large plants and mills with hundreds of machines are naturally interested in multi-purpose greases. Here, the machines in each plant often differ widely in design and operation, and their bearings also differ in type and lubrication requirements. Because of this, it is not unusual for such a plant to stock six or more greases. Hence, careful supervision becomes necessary to

avoid bearing failures with consequent long-time shut downs of machines due to mistakes in application of the greases. Bearing replacements are often difficult to obtain and, more important, idle machines cut into production schedules. The use of multi-purpose greases coupled with training of greasers in correct application and maintenance has been proved effective in solving this type of problem.

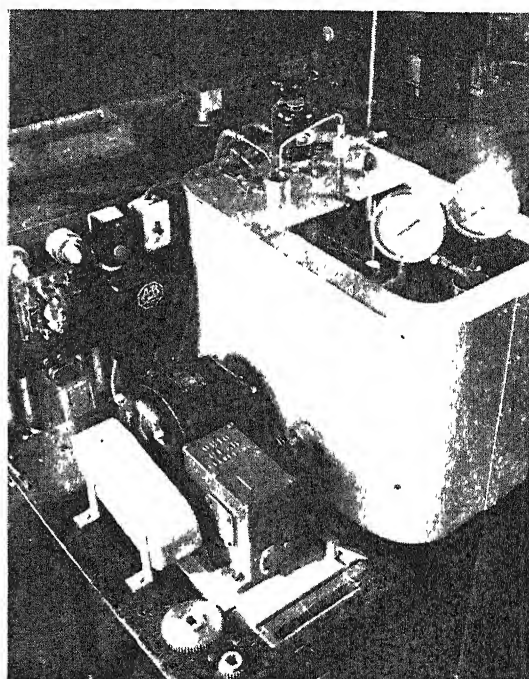
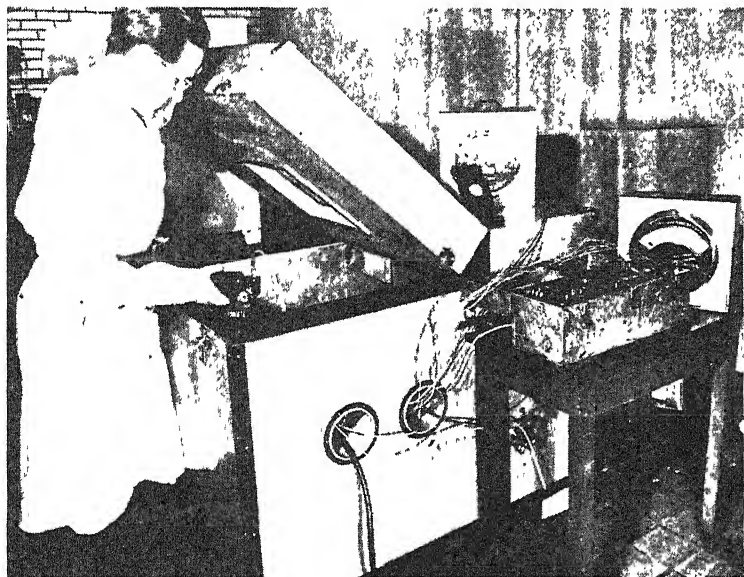
AUTOMOTIVE DILEMMA — Operators of truck and bus fleets have also shown interest in multi-purpose greases. In this field, development has proceeded to the point where a single grease has been offered

which will adequately lubricate bearings of trucks and buses from bumper to bumper

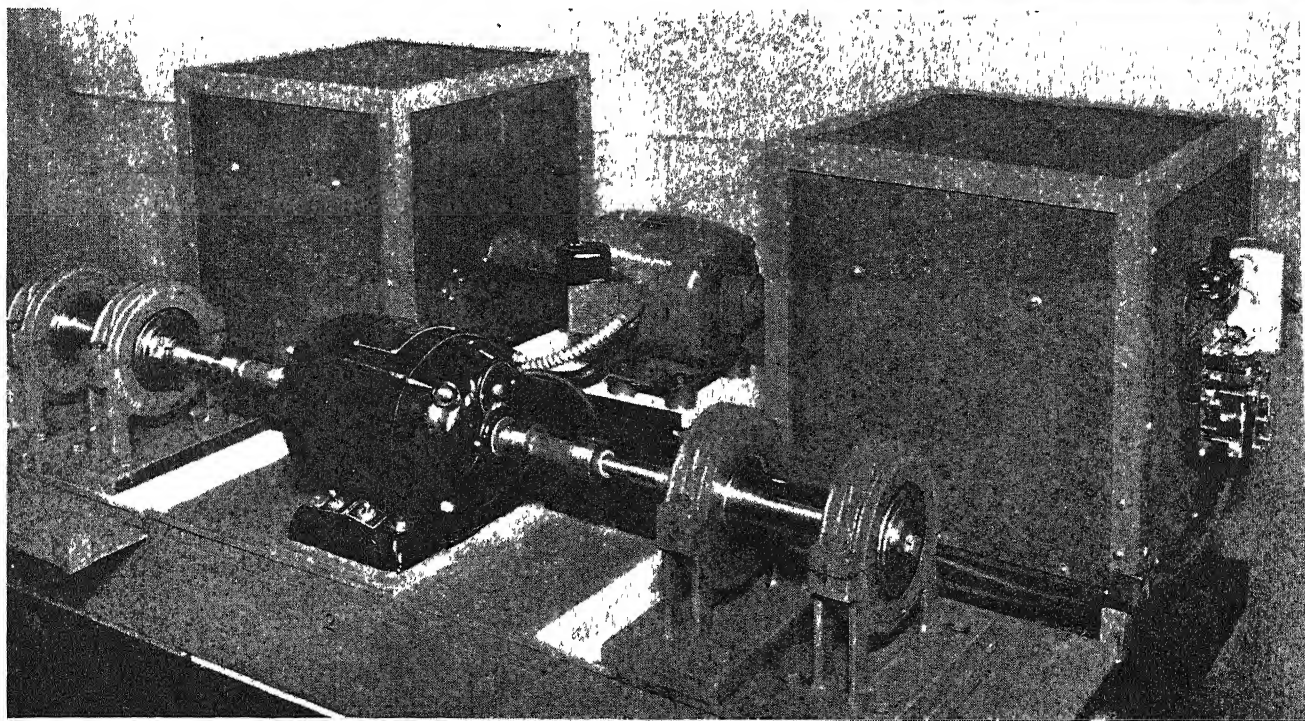
In this connection, however, the extent to which bearings of trucks and buses vary in design and operating conditions is seldom fully realized. In universal joints, for example, the bearings may be bushing, needle, ball, or roller types. Some water pumps are equipped with ball bearings while others use plain bearings. Also, in some water pumps the grease has to function not only as a lubricant, but as a seal to prevent water leakage, whereas other designs include spring-loaded seals which will operate properly only when greases of soft consistency are

employed. The bearings which account for the largest consumption of grease are the so-called chassis fittings—spring shackles, king pins, tie rods, and drag links. Grease is also used as lubricant for wheel bearings, brake cams, clutch release bearings, constant velocity joints, and for certain designs of magnetos.

Essentially there are two ways to approach the truck and bus fleet's problem. Going down one path, the objective would be to analyze carefully the requirements for each type of bearing and operation, and design a product to provide maximum service for each type. The second path—use of multi-purpose greases—



Low-temperature cabinet (above), viscosity-determination unit (right), and ball-bearing grease evaluator (below) exemplify apparatus that is constantly devised as new grease research problems are encountered



leads to compromises. The objective here would be to provide a grease which, while not the absolute best for any one type of bearing, would still do a satisfactory enough job so that when coupled with the economical simplification of stocks thus made possible, a net, over-all advantage would be gained.

The news of unusual types of greases born during work on the requirements of the Armed Forces has prepared the way for wider acceptance of multi-purpose greases. Indeed, reports concerning lithium-base greases sometimes have been so enthusiastic that they encouraged conclusions that even an all-purpose grease is now available. An all-purpose grease would have to be, by definition, a product which not only had the correct chemical composition, but which would also have to have a consistency that would be satisfactory for all types of bearings and housings. The short review given above of variation in bearing designs will indicate that no one consistency is likely to meet that limitation regardless of composition. Thus, until there is more progress made toward uniformity of bearings, the most practical simplification possible is acceptance of multi-purpose greases.

PRACTICAL CONSIDERATIONS —

The successful utilization of a multi-purpose grease is dependent on the installation of adequate dispensing equipment and on avoidance of extreme ranges of operating temperatures. The design of the grease guns must be dictated by the properties of the grease. In some cases, the grease technologist is often forced to fit his formulations within the limits prescribed by the grease guns already available rather than to develop the product demanded for most efficient lubrication of the bearings. Thus, if a multi-purpose grease is employed, the greasing equipment must be capable of handling not only the soft, often semi-fluid consistencies common for chassis greases, but must also take care of products considerably stiffer.

It is conventional to refer to consistencies of greases in terms of ASTM penetrations. An ASTM worked-penetration of 350 means that under conditions carefully specified by American Society of Testing Materials' Method 217-44T, a cone assembly weighing 150 grams sank 350 millimeters in the grease in five seconds after the grease had been worked by forcing it through a perforated plate 60 times at 77 degrees, Fahrenheit. High-pressure grease guns, built to handle chassis lubricants with ASTM worked-

penetrations of 325 and softer will not operate satisfactorily with wheel bearing greases which normally have ASTM worked-penetrations from 250 to 300. Wheel bearing greases, however, must have that consistency because otherwise they may leak past the seals and possibly lead to burning and seizure of brakes. The ideal lubricant for wheel bearings would be a heavy oil or semi-fluid grease, but no seals have been produced in commercial quantities which will hold such fluid lubricants in position. On the other hand, firmer greases than now are used for spring shackles could be used to advantage for those and similar bearings as they would be more resistant to being squeezed out.

The importance of correct lubrication of wheel bearings is so obviously the controlling consideration, a multi-purpose grease would have to be based primarily on the consistency demands of that application. Experience has shown that most of the other bearings will be satisfied by that consistency if the composition of the grease is of sufficiently versatile character. The exceptions would be for bearings where only a soft grease can be used in order to insure proper distribution, as, for example, in constant-velocity joints and where extremely high, localized temperatures are expected, such as those characteristic of magnetos.

The use of multi-purpose greases quickly becomes more difficult if operating temperatures vary over wide limits, because of the consequent extreme variations in the consistencies of the greases. Aside from composition, which is determined by the manufacturer, the factor which has the greatest effect on consistency of greases is temperature. A certain widely used wheel-bearing grease having an ASTM worked-penetration of about 250 at 77 degrees, Fahrenheit, will harden to a penetration of about 50 at minus 20 degrees, Fahrenheit. Also, if a grease that is firm at low temperature were used in king pins, tie rods, and drag links, steering would become quite difficult. In brief, in some sections of the country it is advisable to use so-called "winter" and "summer" grade greases, the former specifically manufactured to meet cold-weather conditions. The use of a multi-purpose grease in such areas obviously introduces a serious complication.

In conclusion, it may be stated that grease technology has made important advances under the pressure of recent demands and that the fundamental information gained is being translated into benefits for industrial requirements. One evidence

of this trend has been the offering of a multi-purpose grease which under certain conditions will enable an attractive reduction in the number of greases formerly employed for a complete grease service job. The ideal has not yet been achieved, however, where a multi-purpose grease may be furnished without careful study of all conditions and, certainly, the all-purpose grease has not yet arrived.

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PAINT REMOVAL

*Simplified by Oil
On Spray-Room Walls*

AN UNUSUAL use for a material known as Castor Machine Oil has been discovered by an automobile manufacturer. This oil is made to be adhesive and stringy, which properties make it ideal for its rather novel application.

The product is mixed with a soap and put on the walls of paint rooms in which automobile body parts are spray painted. Thus, paint from the various spraying operations which collects on the coated surface is easily removed each night with a putty knife, and excessive amounts of paint are prevented from collecting on the walls.

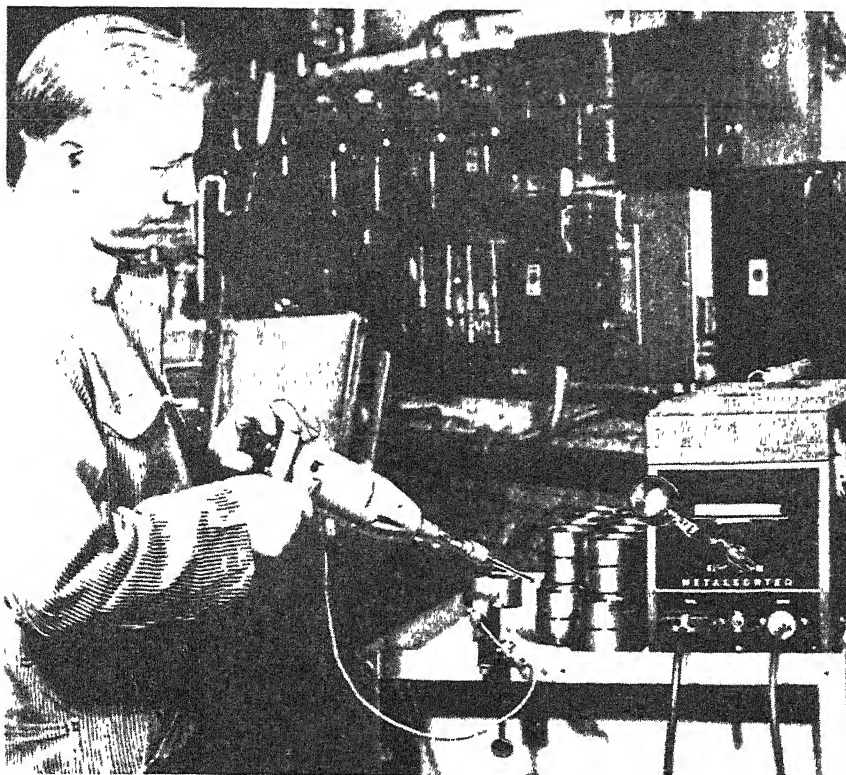
PLASTISOLS

*Afford Economical Means
of Applying Vinyl Resins*

POLYVINYL resins, widely used for coating shower curtains, imitation leather, upholstery fabrics, and wires and cables, have usually been applied by complicated processes and expensive roll mills, calendars, and hydraulic presses. To eliminate this need for laminating thin sheets of the resins to the base material, newer means have been developed to apply the resins as liquids.

One such method makes use of a fluid mixture called a "plastisol," in which the powdered resin is dispersed in a liquid plasticizer by mechanical mixing aided by small quantities of a dispersing agent. The fluid film is easily applied by means of knife or roller coaters.

The requirements of such a plasticizer for polyvinyl resins are relatively complex since color, storage stability, and volatility are but a few of the problems encountered. A synthetic material from petroleum has been developed for the purpose by Socony-Vacuum and carries the name S/V Sovaloid C. A fairly light colored, low viscosity, high-boiling oil, the plasticizer is compatible with most of the vinyl resins.



Triboelectric sorter in use—even heat-treated and non-heat-treated metals differ enough metallurgically to be identified by this practical instrument

Mixed Metal Magic

Jumbled Alloy Stocks and Parts can Now be Re-Identified by Using the Small Current Generated when Dissimilar Metals Rub Together. Direct-Reading Spectrometers Speed Analysis, Cut Down Costly Furnace Time

By JOHN MARKUS
Associate Editor *Electronics*

INCREASED production rates, highly critical end uses, closer chemical specifications, and the need for conserving scarce alloy constituents have combined in recent years to focus attention on means for sorting and analyzing both ferrous and nonferrous alloys. Thus, precision and high-speed electronic methods of identifying metals and alloys are now available that will sort metal objects having identical size and appearance. The sorting is quick and accurate, and requires only that the metals be metallurgically dissimilar—even such a small

change in metallic structure as that produced by heat treating can be detected. And now also it is possible to obtain an accurate analysis of a molten metal in less than one minute.

SORTING — One new electronic metal-sorting device employs the triboelectric principle—the same principle that makes sparks when a cat's fur is rubbed backward—to give a yes-or-no reading in a few seconds. It is small enough to be carried easily and is intended for use right in the plant.

Unavoidable mixups of steels and other alloys in various stages of fabrication have always existed in metal-working plants. For example, a stack of billets may upset and spill over, mixing with adjacent stacks having the same size and appearance but different composition. In other cases, machining operations obliterate painted, tagged, or stamped identification markings, and frequently unused portions of bar stock are returned to stock piles after the identified ends have been cut off.

The triboelectric instrument that will sort out such mixups depends

• LOOKING AHEAD •

Less expensive confusion in storing alloy metals. . . Reduction of scrap losses through inadvertent mixing of parts. . . Quick identification of metals in machines needing repair parts. . . Shorter non-productive interims waiting for furnace heats to be analyzed. . Elimination of laboratory "bottlenecks"

on the fact that when two metallurgically dissimilar metals in contact with each other are moved back and forth a voltage ranging from a fraction of a microvolt to several millivolts, depending upon the metals, is generated. The voltage is caused by a re-distribution of electrons on the interfaces of chemically dissimilar substances that are rubbed together.

Since heat treatment of most alloys produces chemical changes, the method can also be used to distinguish between heat-treated and hot-worked alloys coming from the same heat or melt. The manner of creating the moving contact is not critical provided it is carried on long enough to develop saturation potential. For a reciprocating tool operating at ten strokes per second the required period is about four seconds. A lubricant is used on the surface of the standard metal during tests to minimize chances of scoring, because scoring or erosion of metal during the test will introduce an error in indication.

In the commercial instrument, as made by Control Equipment Company, an electronic circuit controls the total operating time for a test

and provides a potential to balance-out stray currents. A motor-driven reciprocating tool having a $\frac{3}{8}$ -inch stroke provides the friction generating motion. In operation, a known or standard rod of metal is placed in the chuck of the tool and is held stationary on the unknown metal. A fork on the tool presses against the unknown sample to make electrical connection with it, completing the circuit through the two metals and a portable, mirror galvanometer. A control is then adjusted to bring the meter pointer to zero, after which a button on the tool is pressed to start the reciprocating motion of the known metal in the chuck. The reading of the microvoltmeter is taken after the tool has been automatically stopped. If the reading is substantially zero, known and unknown metals are identical; if the reading is different, the polarity and magnitude of the reading are indicative of the degree and nature of the dissimilarity.

In general, all metals and alloys may be arranged in a triboelectric series so that a metal which precedes another metal in the table will be positive with respect to the succeeding metal. Thus, if five metals—A, B, C, D, and E—are arranged in this way, C will be slightly positive with respect to D and more positive with respect to E. Conversely, C will be negative with re-

trum is spread out for photographing. The density of the spectrum lines on the negative must then be examined visually or measured with a photoelectric densitometer to obtain the desired information. This is a tedious process with many drawbacks that may impair the quality of a melt and waste as much as an hour of steel-mill furnace time per day.

In the melting, alloying, and casting of metals, a new direct-reading spectrometer can lower costs by reducing the time a melt must be kept at temperature while waiting for an analytical report.

By eliminating the photographic process in the spectrometer and using a dozen or so strategically positioned multiplier phototubes to measure simultaneously the intensities of the desired spectrum lines, darkroom processing is eliminated. One such electronic version of the spectrometer, as made by Applied Research Laboratories, will determine the chemical analysis of a properly prepared sample in about 45 seconds.

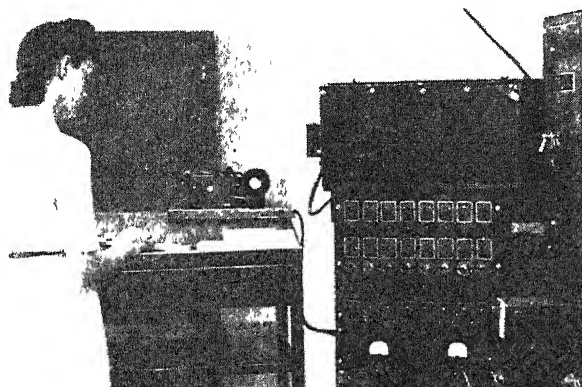
The spectrometer unit contains a spark source, a primary slit, and a diffraction grating to spread out the light into a spectrum, much as in a conventional spectrograph, but beyond this the resemblance ceases. There is a long focal curve along which slit-covered receivers can be

moved to receive the light from any spectral line desired. As many as 12 receivers, each with its multiplier phototube, amplifier, and associated electronic circuits, can be positioned along this curve without serious interference between them and in such a manner that several lines close together in the spectrum can be measured simultaneously.

The radiation which passes through a receiver slit falls upon an electron-multiplier phototube. The output current of this tube, which is proportional to the intensity of the light falling upon the cathode, is then integrated and converted into a series of electrical impulses, the sum of which is proportional to the integrated intensity of the spectral line. These impulses are amplified by means of an electronic amplifier, which is a part of the receiver, and passed on to the recording console.

The spectrometer unit is about five feet high, nine feet long, and four feet deep, with enough room at the back for a man to sit inside and make focussing adjustments in the dark. Thus no special dark room is required to house the unit.

The recording console, a separate device almost as large as the spectrometer, furnishes the final analytical results. For each phototube there is a motor-driven electromagnetic counter driving a 50-inch tape on which is printed a percentage sequence corresponding to the typical spectrochemical working scale. Each tape starts at its reference point, and advances one number at a time at a rate determined by the intensity of the spectrum line it represents. The count is terminated at a definite integrated intensity on the standard spectrum line being used for reference. The chemical percentage for each element being measured can then be read off directly from the numbers visible on the tapes at the reading apertures. The operator only needs to enter

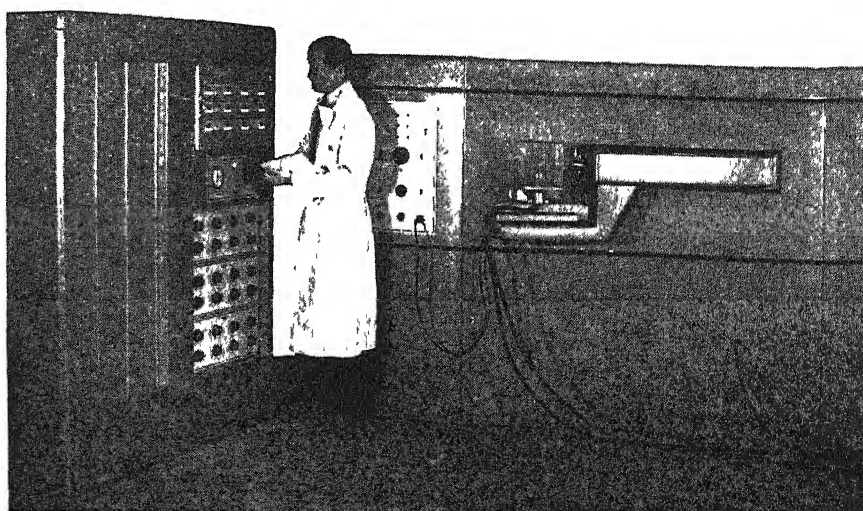


Magnesium alloys are analyzed (left) and the results recorded on paper by fully automatic spectrometer used at Dow Chemical plant. Similar unit (below), made by Applied Research Laboratories, is direct-reading, speeds steel-mill operations

spect to A and B. Once prepared, a table of this kind can be of great assistance in rapid sorting.

Since this instrument provides a non-destructive test, it may be applied to identification of built-up machinery, assembled vehicles, or any combination of metals. The fact that the pieces being tested are in metallic and electrical contact with adjoining members does not affect the accuracy of the test.

QUICK ANALYSIS—In the basic spectrometer, as used in an open-hearth steel mill, a small sample of the material to be analyzed is melted in an intensely hot spark and the resultant characteristic light spec-



these results on his analytical form, press a button to re-set the recorders, and the unit is ready to analyze the next sample.

In this manner has been solved one of the most annoying limitations of spectiography—the necessity of having the lines of the elements to be determined at about the same level of intensity. A still greater problem—variable contrast of the photographic emulsion with wavelength—also vanishes because the multiplier phototubes have a linear response.

With this direct-reading spectrometer, alloys can be analyzed at the rate of 25 seconds per determination, compared to three minutes per determination with the photographic method. Up to eleven elements can be analyzed at one time. Control circuits make it possible to have several different types of conditions ready for instant use, so that several alloys may be analyzed alternately without readjusting the machine.

ECONOMIES—The rapidity of operation provides a “pour or not-to-pour” analysis, in the case of metal production, in a minimum of time. Here, every minute saved is a minute less of furnace time required. Cutting such an analysis from ten minutes to less than three minutes from the time the sample is received provides real economies in fuel, overhead costs, and so on.

An example of these savings is the case of producing high-grade steels in an electric furnace. The furnace may be charged from scrap or with metal from an open-hearth furnace. In the former case, about three to five hours will be required to melt down the scrap. Just as soon as the charge is thoroughly melted, a preliminary eight-element analysis will be required to determine the residuals in the steel. Whether it takes one minute or ten minutes to perform this analysis is not particularly significant when just one furnace is being considered, as the main purpose of the analysis is to determine whether the steel needed can be made from that particular melt, or whether the residuals are such that another type must be produced. This analysis is usually followed with other preliminary ones to control the refining process.

The first important analysis from the standpoint of possible time saved is the one just prior to the “slag off.” If the various residuals have been brought down to specifications, the oxidizing slag can be removed and the deoxidizing slag put on the heat. Thus, if carbon can be determined in a few minutes by a high-

speed method and the other alloying elements by a method just as rapid, at least eight minutes of furnace time can be saved at this point. If the results of the analyses are such as to allow the slag off, these same analyses can be used to determine the correct additions to bring the melt to the desired steel specifications.

After making these additions, another half to three quarters of an hour prepares the steel for tapping. However, before the actual tapping can be done, the final sample must be analyzed. If this analysis can be concluded in two minutes—instead of ten or fifteen—at least eight minutes can be saved in determining whether to pour. Thus, in the operation of just one electric furnace, at least 16 minutes can be saved in every melt of from five to eight hours. In a 24 hour day, about one hour of furnace time could be saved per furnace by a direct-reading instrument over that required with a standard spectrographic installation.

Exactly the same kind of analyses are required in casting, forging, or fabricating with steel. Hence direct-reading spectrometers can be applied to any of these fields. Whether such applications will lead to large savings depends considerably upon the magnitude of the operations involved and their intricacy. In all cases where work must wait on laboratory analysis, the double saving of general operating costs and laboratory costs can often justify the installation of direct-reading equipment. Even in cases where only laboratory costs are involved, but where a large volume of testing must be handled, the greater speed of the direct-reading instrument over spectrographic methods or chemical methods often make its installation economically desirable. Likewise, savings have been shown for the aluminum and magnesium manufacturing fields.

A somewhat similar automatic spectrometer developed by the Dow Chemical Company for the same purpose records its results on paper. This machine has been in use in the company's magnesium alloying plant for several months, and can give an alloy analysis in 40 seconds, a fraction of the time required by former techniques. Amounts of up to 14 elements present can be determined simultaneously. Girl operators can be trained in one day to use the instrument efficiently since the entire operation is fully automatic from the time the metal samples are placed in the instrument until the analysis is recorded on paper for reference or filing.

PLASTICS BALLS

*Sealed Air-Tight in
Matter of Seconds*

DIELECTRIC electronic heating is being used to join large strips of Vinylite in air-tight, water-tight seams for giant toy balls. The sections of the thermoplastics to be sealed are placed between metal electrodes supplied with radio-frequency power from an RCA, two-kilowatt electronic generator and fusion of the surfaces in contact is a matter of seconds.

According to the DuPage Plastics Company, this tough, lightweight 22-inch diameter ball could not have been made on a practicable basis by any other heating method. Conventional stitching would have required a separate water-proofing operation.

HORSESHOES

*Made with Aid of
Electronic Heating, Welding*

AN ELECTRONICALLY controlled welding press is now being used to join the toe calks to horseshoes in a mass-production operation. Pre-heating of the shoes is done by another electronic unit, a 20-kilowatt electronic heating generator near the welder. In this first operation, it takes about eight seconds to heat the shoe to a temperature of about 1200 degrees, Fahrenheit. Resistance welding of the shoe to the calk is controlled by an electronic timer that determines duration of the current flow for each pulsation of welding current. The total number of pulsations and the cooling time between pulsations are controlled by a sequence timer. Output of the machine is 360 shoes per hour, and these contribute to the total of 20 million horseshoes manufactured annually.

TELEVISION TUBES

*Ride Conveyor Line
on Mass-Production Basis*

COATING of the glass bulbs of large television tubes is now done on a mass-production basis, 10 workers turning out more than 1400 tubes a day.

At one end of the room the bulbs are washed and placed on a conveyor that carries them to a baking oven. After baking they go to an automatic spray machine that coats the face of the bulb with phosphor powder. Other conveyors take them to inspectors, wipers, and oven operators. None of these workers need move from their positions; the conveyors do all the transporting of the fragile bulbs from place to place at a North American Philips plant.

Looking To The Light

Refuting the Belief that Modern, Engineered Lighting Must Always be Costly and Involve Extensive Re-Building, the Bowditch Grade School Experiment is Cheerful Proof to the Contrary. Standard Fixtures, A Little Paint, and A Lot of Thought were the Keys to Better Seeing

LIKE many another American grade school, the Bowditch School in Salem, Massachusetts was built 30 or more years ago. And, again in common with hundreds of typical schools, the lighting—both artificial and natural—was something less than all that could be desired. Blackboards were genuinely black and soaked up a good share of the available light. Reflections were hard to control, and the familiar cry of "Teacher, I can't see the board" was heard in spite of various combinations and manipulations of window shades and room lights. Windows that were intended to provide natural illumination did only half the job—the side of the room farthest from them was too dark—yet the glare from the sky was too bright. All in all, the problem was a difficult one, yet an old and common one. Its solution required the combined skills of functional painters, illuminating engineers, school-furniture designers, and educators.

Aimed at this solution was the establishment of Room 4 at Bowditch School as an experimental laboratory in the form of a working classroom. Here, the four windows faced southwest, reached within six inches of the ceiling, and had a glass area equal to 19 percent of the room floor area. Artificial lighting consisted of nine conventional open-shade lights with one 100-watt and eight 50-watt bulbs. Three standard blackboards lined as many walls, and the familiar school desks supplemented by a very ordinary color scheme and a picture of George Washington completed the scene of primary education.

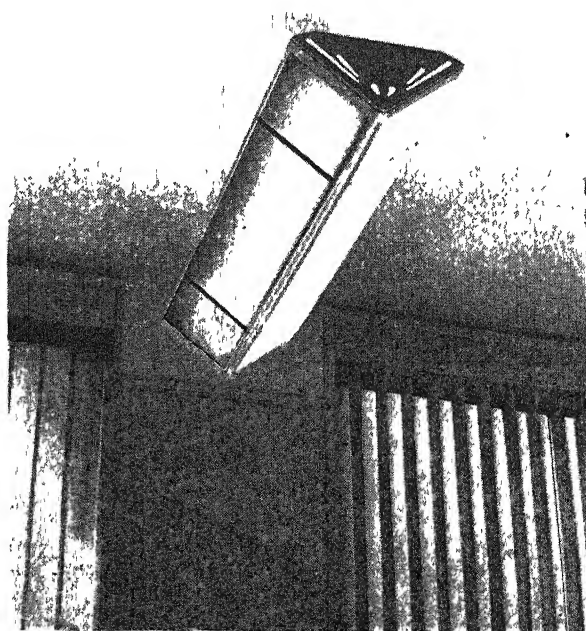
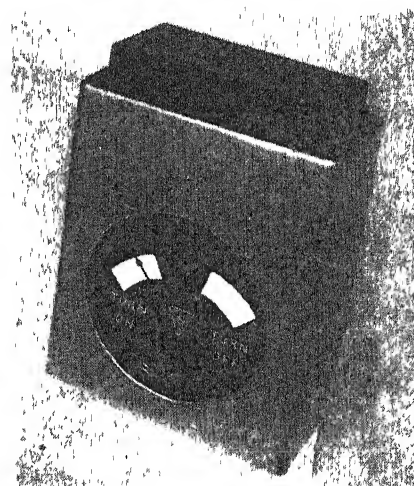
As outlined originally, the plan for remodeling Room 4 for "laboratory" use involved five basic factors. For one thing, it was important that the artificial lighting equipment or "luminaires" would not be

so different from the standard fixtures as to require special installations and construction. Other equally important points included the necessity for controlling the entrance of daylight; high reflection factors for the main surfaces in the room; furniture conducive to correct body positioning for optimum light utilization, and a color scheme contributing both to a pleasant atmosphere and correct mixing of artificial and natural light.

LUMINAIRES—In the schoolroom as it was remodeled, the foregoing factors supplemented each other and blended together to produce a harmonious and efficient result. Each, however, presented individual problems and the arrangement currently in use is not regarded as a final solution to schoolroom lighting but rather as a working stage in experiments to that end.

The fluorescent luminaires se-

lected were of a standard, triangular-shaped type and mounted two feet below the ceiling. To reduce the brightness of the sides of the lights facing the students, however, the glass on that side was replaced by a modified glass of greater density. This resulted in a satisfactory general brightness level and also produced an asymmetric light distribution with the greatest illumination coming from the sides of the lights toward the blackboards. Thus, with the brightness on the "blackboard" side having nearly twice the value of the brightness on the "pupil" side, no extra lighting was needed for good blackboard illumination.



School-room light meter (above) fixed to monitor's desk, tells when extra, or less, light is needed from fluorescent lamps (left). Louvers on windows in the background control sky glare, team with asymmetric light distribution from lamps to boost blackboard visibility.



Photographs courtesy Sylvania Electric Products, Inc.

Poor light and sky glare (above) mark original fifth-grade room. Re-modeled room (right) lost old faults, gained in appearance, took no major changes

It should be pointed out, however, that if the children had been seated around tables rather than facing the front of the room the asymmetric light distribution would not have been installed. A similar situation is found in industrial lighting installations where, for example, a shop may have areas where a number of workers are seated and facing a given direction; and other areas where machines are placed at a variety of angles to provide aisle clearance and so on.

Control of the fluorescent lights is based on three rows of fixtures running longitudinally of the room ceiling. The lamps in the row nearest the wall burn at all times when the room is in use. This is necessary to provide a minimum of 40 foot-candles at desk-top level. The central row of lamps, and the row nearest the windows, are controlled by a "monitor" pupil who switches them on according to the indications of a simplified light meter fastened to the desk. The meter is not calibrated in numerical marking but rather has two windows—marked "turn on" and "turn off"—through which a needle shows when lamp control is necessary.

Ordinarily, the monitor is called upon to operate only one switch which controls the lower lamps in the middle row of fixtures and the upper lamps in the fixtures adjacent to the windows. Another switch controls the lower lamps in the win-



dow row and is used only at night or on unusually dark days. An interesting sidelight on the actual lighting is furnished by the morale factor associated with the monitor's operation of the lighting switches.

Here it is apparent that even at an early age, members of a group take pride in having some degree of control over their working environment. In this case, the work time lost is negligible since the indicator needle is ordinarily unseen behind a blanked-off area of the meter face and only appears when the light level falls below the desired 40 foot-candles or passes above the 60-footcandle level. The success of the

• LOOKING AHEAD •

Fewer mistakes, more accurate work in schools and industry alike with better light. . . Recognition that light control is as important as light intensity. . . Paint experts and lighting engineers merging knowledge . . . Careful planning for use of economical standard fixtures in better-than-standard arrangements.

plan indicates that a similar arrangement might well be adapted for lighting, ventilating, and like controls in industrial plants.

WINDOW LOUVERS — Coupled with the need for a well controlled artificial lighting system was an equally important demand for regulating the daylight entering the room through the side windows. In this case, the problem resolved itself

into four major considerations. Excessive sky brightness at forward angles had to be eliminated. At the same time, however, provision had to be made to allow the children to view the sky by looking towards the windows—this to avoid any undesirable atmosphere of a "closed" room. In addition, it was important that as much daylight as practical reach the side of the room away from the windows and, moreover, that the first three objectives be attained without installing devices that required adjustments more involved than the usual management of a roller shade.

Some experimenting was done

with Venetian blinds but these were discarded in favor of vertical steel louvers oriented by non-adjustable fastenings at 90 degrees to the window glass. It was decided that minor gains in effectiveness that could be obtained through the use of adjustments for the louver angles were outweighed by the possibility that the louvers would be left in the wrong position. The four-inch wide louvers—spaced at $3\frac{1}{2}$ inch intervals—were formed in a slight “S” shape and possessed the advantages over Venetian blinds of both strength and easy cleaning. As further convenience factors, the louvers were hinged to swing outwards for window washing and afforded enough space between them to eliminate any troubles in reaching the window latches.

Viewed at a 45-degree angle, the louvers completely screen any direct view of the sky, thus cutting off the glare for the students whose line of sight is directed towards the front of the room. From this angle up to 90 degrees the brightness of the sky increases gradually and thus provides the desired result of not screening the pupils entirely from a view of the outside.

When conditions are such that direct sunlight would penetrate the room, a light, translucent, roller shade located directly behind the louvers may be adjusted to prevent excess illumination.

After installation of the louvers, the daylight illumination within the room was checked with a footcandle meter and found to be much more uniform than it was before. Expressed in brightness ratios, the contrast between window and sidewall—narrow sidewall between windows—was 150:1 before providing the louvers. Similarly expressed, the ratio of the windows to the front wall was 55:1 without louvers. After the louver installation, these ratios dropped to 7:1 and 2 $\frac{1}{3}$:1, respectively. In all cases the brightness measurements of the windows were taken at an angle of 45 degrees. The effectiveness of the louvers is apparent from these figures and, in addition, it was pointed out that their cost would be less than that of Venetian blinds if they were made on a quantity basis.

PAINTING FOR LIGHT—To gain the fullest value from the new lights and window louvers, a change in the school-room color scheme was worked out with a particular eye to both color harmony and reflectivity values. Another factor, that of warm and cold colors, was decided in favor of the warmer colors both because of the fact that the room was most

used during the cooler months and because the warm colors selected retained the same general appearance under white fluorescent lighting as they offered under daylight.

In attempting an accurate description of the colors finally evolved for the room, the engineers encountered the traditional lack of exact color terminology. In general, the upper wall is a light coral and the lower wall or dado a slightly deeper coral. The exact proportions of paints and colors were determined by experimental mixing under both natural and fluorescent lighting. The ceiling area was white with a trace of wall color, and the louvers were treated the same as the lower walls. Further efforts to obtain a good reflection factor in the room involved the installation of a light grey, asphalt-tile floor with a marbelized pattern to make heel marks less prominent.

FUNCTIONAL FURNITURE—Recognizing the necessity for proper posture if lighting and vision were to be held at efficient levels, the Bowditch School removed the old-style desks and installed the modern “functional” type of seat. The seat, designed to fit the body quite closely, and adjustable to accommodate students of varying size, incorporates a $18\frac{1}{2}$ -degree tilt in both desk top and back. The seat automatically tilts forward and back to meet shifts in body position.

The entire re-modeling job has brought about a surprising increase in light uniformity and effectiveness. Moreover, the results were achieved without deviating towards expensive and custom-built lights and equipment and is, therefore, adaptable to the needs of many schools both old and new. The same essential lighting problems appear in many industrial plants and offices and may well be solved by following similar lines of approach.

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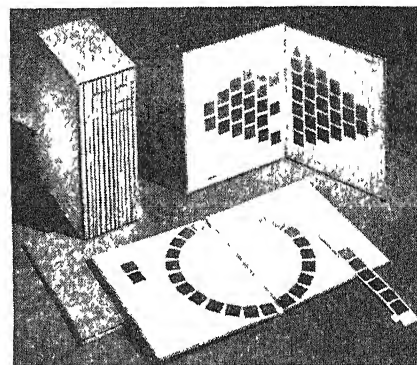
COLOR CHIP MANUAL

*Re-Issued In Large Edition
for Better Visual Impression*

OF INTEREST to all persons who work with color is the publication of a Large Chip Edition of the Color Harmony Manual by Color Laboratories Division, Container Corporation. In this edition, the individual color chips are one-inch square plus a tab, providing two and one-half times more working area than the chips in the first, 1942 edition. Some advantages of the larger

working area of the chips are the increased speed with which a visual impression of a color is gained, and the ease with which color matching is accomplished. Also, the necessarily larger charts—11 by $18\frac{1}{4}$ inches when open—are more appropriate for teaching and for presenting color schemes before groups of people.

The shape of each chip incorporates a tab on which is printed the complete Ostwald notation for that color. All chips are removable from their positions, which are marked accordingly for easy return,



Manual includes 12 books, 680 chips, work chart, gray-scale holder, and text

and the location of any Ostwald notation is evident from a glance at the transparent flyleaf which is printed with all letter notations.

The chips in both editions of the Manual are identical in color. Thus, the colorimetric specifications for the dull sides of all 680 chips apply equally well to both editions.

A new feature of the Large Chip Edition is a work chart in which the chips may be arranged for study in circular or linear series. Also included is a 24-page text which explains the basic Ostwald principles of color order in non-technical language, and tells how to use them to obtain harmony in color.

SPOT-WELDER

*Adjusts Work Table,
Controls Electrodes Electronically*

ONE of the largest of its type known in existence today, a new multiple-spot-welding machine has been placed in operation at a Pullman-Standard Car Manufacturing Company's plant and is expected to increase production in the department about 30 times over present processes.

Weighing more than 90,000 pounds, the huge machine was built by National Electric Welding Machines Company after extensive study of the operations involved in welding “stiffeners” to the interior of car sides to give them the sleek appearance dictated by today's

streamliners A stiffener is not visible, but is a sheet of light-gage corrugated metal which is welded inside the walls of the car to lend strength and smoothness—much on the same principle as the corrugations on the interior of a cardboard box.

In operation, a metal table 30 feet long and 10 feet wide travels beneath a battery of 48 stationary welding electrodes The work to be welded is laid flat on the table, which has been covered with a copper plate As the table moves slowly beneath the row of spot-welding electrodes it is adjusted to stop at proper intervals, the electrodes then automatically lower, making contact with the work and securely welding the stiffeners to the car side. The electrodes then lift up and the table moves on to the next position, where the process is repeated

A photo-electric cell control makes the operation largely automatic. Along one side of the moving table are drilled two rows of small holes about a quarter of an inch apart A beam of light is directed from beneath the table, through these holes When the beam strikes the photo-electric cell above the holes, the control circuit is completed which stops the table, lowers the electrodes, makes the weld, lifts the electrodes, and starts the table into operation again.

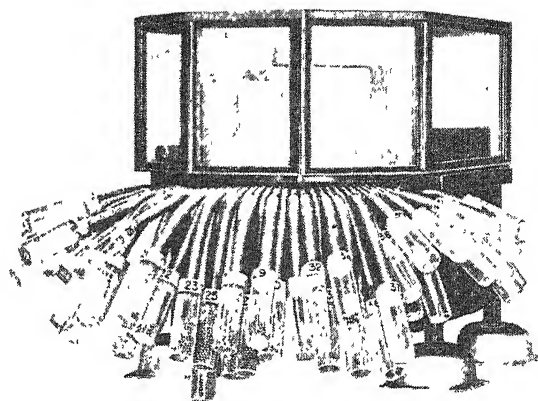
By dropping loose rivets into all the holes not needed in the operation, the position of welding is pre-set.

ATOMIC POWER

*For Electrical Generators
Unlikely to Lower Current Costs*

FUEL costs are such a relatively small figure in the over-all expense of generating electricity that atomic power plants would reduce residential electric bills only slightly, according to a recent Westinghouse estimate. The cost of carrying the power into homes and industries,

After four successive washings, steel balls pass through sorter and are directed to glass vials Any one bearing is assembled with balls of similar dimensions



the investment required for central generating stations and distribution stations, and equipment maintenance, far outweigh the fuel bill, it was explained

BALL-GRADER

*Holds Unusual Tolerances
To Aid Bearing Uniformity*

PRODUCTION-line precision evidences a high stage of development in a new machine designed for sorting and grading the tiny steel balls



Placement of light-blocking rivets (above) controls welding positions Full view of welding machine (below) shows 10- by 30-foot traveling table

used in bearings on movie projectors—the machine is accurate to within .00002 inch. The close measurement is said to be necessary in order to effect maximum uniformity among all the balls used in any one bearing assembly

Before being placed in the grading machine, according to the Bell and Howell Company, each group of balls undergoes four successive cleaning baths, to remove any trace of oil or other foreign matter which might cause erroneous measurement. After being passed through the glass-enclosed grading machine and sorted, the balls are guided into numbered chutes, the ends of which are connected to glass vials by means of flexible tubes. The various vials are carefully labelled, and their contents are kept separate, so that only balls of the same size are used in assembling any one bearing. Following grading, the balls are re-lubricated with high-grade, acid-free oil, and the vials then are sealed and marked with the size numbers.

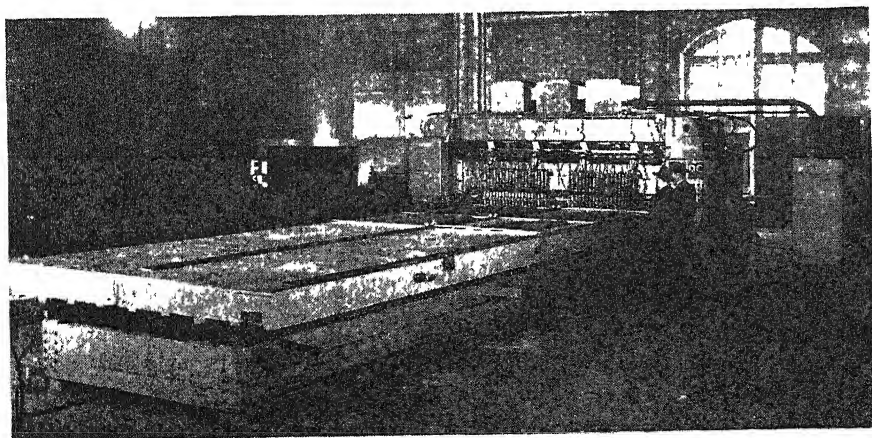
GLASS FILTERS

*Help Purify Air
in Penicillin Plant*

IN FIBER form, glass is being employed to filter bacteria and other foreign properties from the air used in the production of penicillin.

At the E. R. Squibb and Sons penicillin laboratories, a loose, fine-fiber type of Fiberglas is used since it does not pack down under steam sterilization. The fibrous glass operates under pressure. Outside air, drawn through intake filters, passes through compressor, after-cooler, and separator, thence through a glass filter bed and into the fermenter tank.

The glass fibers used in the penicillin application are only .00028 of an inch in diameter, as compared with the much coarser fibers used in warm-air heating systems in homes and industries.

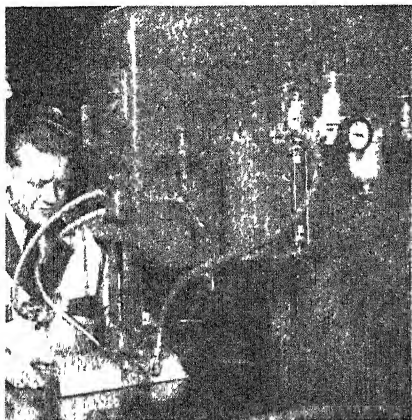


New Products and Processes

BAND-SAW LUBRICATOR

*Sprays Metered Mist,
Avoids Messy Work Table*

AN ECONOMICAL, clean method of heat dissipation is the description applied to a new spray lubricator for attachment on high-speed band saws. Faster cutting rates, improved finish, and increased saw life are the results claimed for its use. The attachment, for DoAll saws, is simple to install and is a



Saw teeth lubricated at point of work

rugged, heavy-duty, fool-proof device operating from a standard air-pressure line.

The spray head straddles the saw blade from the back and directs two streams of lubricated air against the teeth of the saw. Lubricant is thus forced in the form of metered mist into the saw teeth as they enter the work. Use of coolant is regulated by a metering valve. It is said that the work table thus does not get wet or messy.

The DoAll Spray Lubricator has been designed primarily for use in cutting nonferrous metals, but also works on many types of plastics and laminated material where friction between blade and work softens the material to a gummy state.

HUMIDITY TESTER

*Simply Made with
Variable-Color Ink*

SUITABLE for brushing, spraying, or printing on paper, cloth, metal, or other surfaces, a humidity-sensitive ink dries in a few minutes at any temperature from 110 to 150 degrees, Fahrenheit. At room temperature it dries in about an hour if the relative humidity is below 50 percent.

Called HygroInk, the ink, when dry, turns from blue-green to pink as the humidity increases. The color change is distinct, definite, and reversible.

When conditions are suitable for mold, mildew, corrosion, rust, and so on, the ink mark shows a warning pink.

As a simple testing device a tab of paper marked with the ink may be buried in powder, flour, cereals, tobacco and similar products, or it may be used to check the atmospheric humidity of work rooms or storage areas.

FLOOR CLEANER

*Reduces Slipping Hazard,
Improves Cleanliness*

OIL, grease, and water absorbent, a product made from an alumina silicate material is said to be capable of absorbing from 120 to 140 percent of its own weight. Used on oily, greasy, or wet floors, the absorbent helps eliminate the danger of accidents due to slipping, at the same time keeping floors clean and reducing fire hazards.

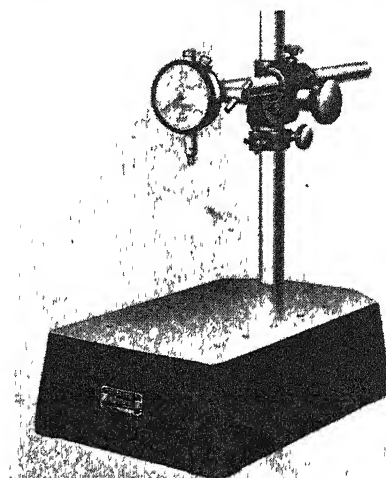
The granular, absorbent material is free of dust, non-abrasive, and "tailor-made" to give maximum service to the user without sacrificing its absorption qualities. Weighing up to 30 pounds per cubic foot, the manufacturers, Blue Mountain Clay Company, Inc., maintain it gives a greater coverage per pound than ordinary mineral products.

DIAL COMPARATOR

*Adjusts to Position Easily,
Accommodates Work Clamps*

ANNOUNCED by Standard Gage Company, a new dial comparator model is described as suited to a wide variety of uses due to the extensible indicator support arm and the tapped holes in the platen for securing the work. Any dial indicator having a standard lug-type back may be used.

By means of a double clamp ar-



Vernier screw facilitates setting up

range, the indicator support arm may be slid up or down on the vertical column, swung to any angle in either a horizontal or vertical plane, and moved to place the indicator at the desired distance from the column. Setting is facilitated by a vernier screw. A friction washer concealed in the swivel prevents the indicator arm from dropping unintentionally when the clamp is loosened for adjustment.

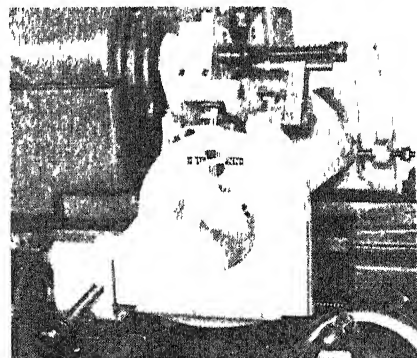
Working area of the platen is 6 by 9 inches. Five tapped holes on either side are spaced at 1½ inches and will receive ¼ inch-20 bolts for securing the piece being checked.

LATHE ATTACHMENT

*Converts Standard Machine for
Automatic Small-Parts Use*

DESIGNED as an accessory for either the Atlas or Logan lathe, a recently developed device provides a new means of producing small parts automatically, and with good accuracy, at very low cost. It is claimed by the manufacturer that many small parts, particularly those that require only form and cut-off operations, now being produced on the large and expensive automatics, can be produced just as rapidly, and with equal precision by using this lathe attachment, called "Dynamatic."

The attachment employs face cams to control the operation of rocker



Material feed and closing of collet are automatic and timed to operation

arms which, in turn, control the operation of forming a cut-off tool attached to them. Either circular or flat form tools or a combination of both may be used, the selection of type depending upon size of the production run. The rocker arms operate on pivots instead of slides, thus eliminating the necessity for constant adjustment. A means of adjustment is provided, however, when long usage might make simple adjustments necessary. Since all the pivot parts are precision ground and hardened, adjustment is said to be seldom necessary.

The stock is cam fed through a tube by feed fingers, into a collet, automatically, and a moving stock stop determines the length of the part to be either formed or cut off, or both. Closing of the collet, which is also an automatic operation, is timed to coincide with the start of operation of the work tools.

The attachment is complete and, it is said, can be affixed to the lathe with-

out it being necessary to drill holes or in any way harm or deface the latter, within one to two hours time. It can be removed at will and the lathe restored to normal service.

Power for operation of the Duna-matic is taken from the standard lathe lead screw and transmitted, by means of a roller chain and steel sprockets, through a steel worm and bronze worm gear, providing efficient and, at the same time, quiet operation.

CONICAL CANS

Nest for Compact Shipment or Storage

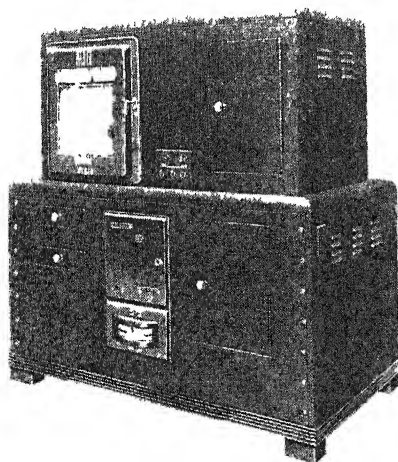
FIVE TIMES the number of nesting, conical tin cans can be packed for shipment, storage, or handling in the same space as required for ordinary cylindrical cans, according to the manufacturer of a new can with slightly tapered sides. Other features of the can are that near the bottom the wall is swaged, providing a shelf around the entire inside on which the can above rests, preventing jamming or sticking.

Forty eight of the coned cans nested one in another form a stack about 42 inches high. This makes possible mechanical wrapping of 48 cans in one small package, and loading them quickly and economically. In this compact form of package, it is said that the cans are much better protected from denting or injury in transportation and storage. The cans were developed by The Francis Company.

RECORDING DILATOMETER

*Operates on 12-Hour Cycle,
Eliminates Plotting Instant Values*

FOR CONTINUOUS recording of the thermal expansion and contraction of a wide range of materials including metals, glass, ceramics, and plastics, an improved automatic dilatometer has

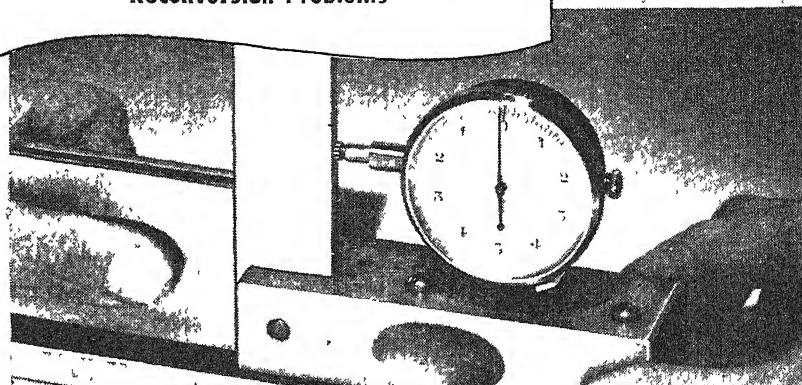


Measures heat reactions automatically

been developed. Graphic recordings of the 12-hour expansion and contraction cycles of samples are provided with a high degree of both sensitivity and accuracy, and operation does not require supervision of a laboratory assistant. Thus both time and labor required for specimen study are reduced.

Ingenious New Technical Methods

**To Help You with Your
Reconversion Problems**



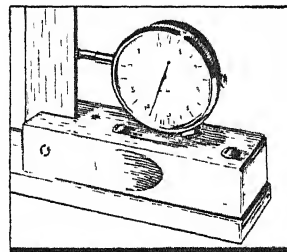
New Micro Square Instantly Checks Right Angles to One 10,000th Inch!

Ideal for precision testing, the Acro Micro-Sine Square quickly and accurately checks right angle work to 1/10,000th inch within a given distance. Its standard indicator dial instantly registers error, location of error, and amount of correction required. Designed for tool and die shops, machine shops and testing laboratories, it also provides a standard for checking master squares, tri-squares and tools.

The Acro Micro-Sine Square is very simple to operate, saves hours of time. Made of hardened tool steel, in ground and lapped precision construction. Available in two types: (1) Standard precision gauge in tenths, (2) Lever indicator in thousandths. Both complete with master checking blocks and carrying cases.

On precision jobs, requiring a static position and mental alertness, workers undergo nervous tension which often results in fatigue. Tests have shown that the act of chewing helps relieve tension—helps workers stay alert, thus increasing their efficiency to do more accurate work. For this reason, many plant owners urge workers to chew Wrigley's Spearmint Gum on this type of job.

*You can get complete information from Acro Tool and Die Works
4554 Broadway, Chicago 40, Illinois*



Standard Indicator Dial



AA-88

Measurements begun during the afternoon of one day may be automatically completed overnight. Except for set-up time, the laboratory assistant is free for other work during the 12-hour recording cycle.

In addition to eliminating the tedious plotting of instant values by older methods, the recording instrument permits determination of true variations in length even when samples exhibit exceptions to the rule of elongation as a function of temperature. This makes the equipment particularly useful in connection with the laboratory study of ferrous alloys at thermal critical points.

The improved instrument is fully enclosed in an attractive steel cabinet permitting ready access for set-up of specimens. Recording meter and other

instruments are flush-mounted, permitting visual indication of operating temperatures and the progress of thermal expansion curves plotting elongation against temperature.

The dilatometer includes a furnace or sub-zero cooling chamber; furnace thermocouple; concentric quartz tube, specimen thermocouple; gearbox and support; transmission; contact mechanism; electronic relay; and recorder. Each one of these principal units performs a separate function but all functions are closely coordinated to hold specimen temperature uniform within 1 degree, Centigrade, and to provide uniform heating and cooling with the specimen in an inert atmosphere, automatic shut-off, and an overall accuracy of 0.2 percent.

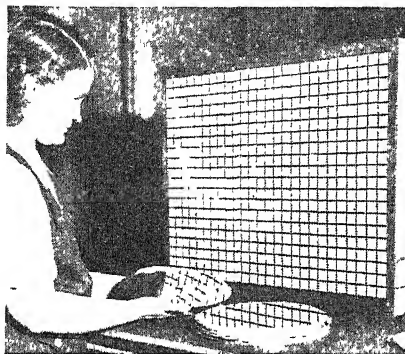
Accommodating three-, four-, or

five-inch specimens, the dilatometer will allow temperatures up to 1000 degrees, Centigrade, weighs 450 pounds, and measures 56 inches wide, 50 inches high, and 26 inches deep. It is designed for use on 110-120 volt, 50-60 cycle supply, and is rated at 900-1000 watts. The manufacturer is the Electronics Division, Sylvania Electric Products, Inc.

DISK INSPECTION

Facilitated by Reflection of Ruled Grid Lines

IN A recording-disk base, dimples or deviations from true flatness are defects that might ruin a priceless re-



Imperfect disk (left) and flat disk (right) are quickly spotted by lines

cording or transcription. This is because an instantaneous recording disk must be perfectly flat. A dent or dimple in the base before it is lacquer-coated to form a recording blank may cause a "skip" or other imperfection in the sound track of the finished recording.

In the past, accurate tests for disk flatness have been difficult. Eye scrutiny of the bases is inaccurate and time-consuming. Mechanical tests are out of the question, because any instrument that touches the disk's surface is practically certain to create its own blemish.

Audio Devices, Inc., manufacturers of recording disks, has recently initiated the use of a ruled board by which the bases mirror their own defects. Employing this so-called "mirrorgraph," the inspector is able instantly to detect flaws in the bases, thereby forestalling many of the difficulties formerly encountered by recording engineers.

STOPCOCK LUBRICANTS

Removed by Use of Naphthalene Solvent

THE many advantages to be gained through use of silicone stopcock grease and silicone high vacuum grease, made by Dow Corning Corporation, have been reluctantly given up by some micro-analytical laboratories because of the difficulty encountered in removing the non-wetting film formed on laboratory equipment by these lubricants. The best cleaning methods previously developed involved use of caustic solutions which had to be carefully watched to avoid etching the glass. Recently, however, a hydrocarbon solvent has been found which

quickly and efficiently removes silicone films from laboratory glassware.

It is reported by G. Constabaris of the Department of Chemistry of the University of British Columbia that the stopcock grease can easily be removed from laboratory glassware by decahydronaphthalene, also known as decalin or naphthalene. The effectiveness of this solvent has been verified in the laboratories of Dow Corning Corporation.

The recommended procedure consists of filling the apparatus with warm decahydronaphthalene (decalin) and allowing it to stand for two hours or more if necessary, subsequent draining and rinsing once or twice with acetone, and drying with a stream of filtered air. It is noted that the decahydronaphthalene can be re-used several times before it becomes ineffective.

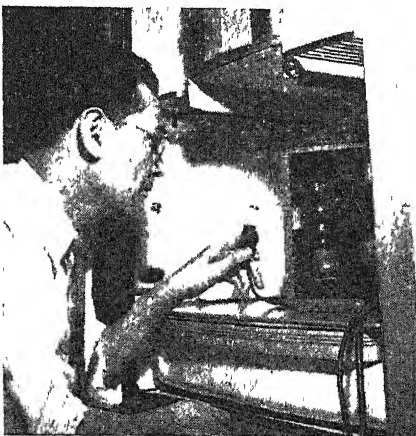
In using the lubricants, only a very thin film is necessary to provide effective lubrication, and judicious use of the greases and frequent cleaning should prevent surface contamination.

BACTERICIDAL LAMP

Stops Refrigerator Odors, Occupies Little Space

A MIDGET ultra-violet lamp, the size of an automobile headlight bulb, has been developed as a bactericidal unit to be screwed into a niche of a refrigerator cabinet's interior. The new lamp simultaneously pours forth a barrage of bacteria-killing rays and produces ozone in the cabinet's air. It is recommended for both high humidity and low humidity types of mechanical refrigerators, according to the Westinghouse Sterilamp-Tenderay Department.

Advantages of the bactericidal radiation are said to be odorless refrigerators, improved sanitation, longer preservation of food in its original stored state, and checking of the growth of mold and bacteria on food. The ozone, it was explained, diffuses rapidly



Lamp provides ozone, ultra-violet rays

throughout the entire cabinet, purifying the food vapors by breaking down the vapor molecules. The ultra-violet destroys air-borne bacteria, viruses, mold, and food odors within the range of its radiation.

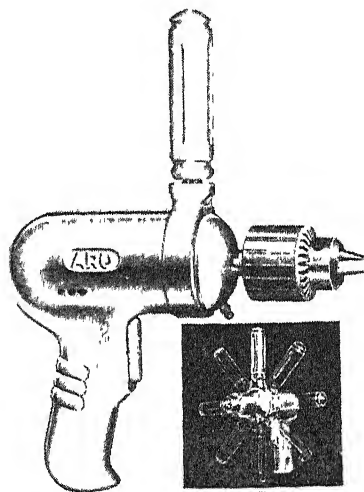
Burning only when the refrigerator compressor is operating, the three-

and-one-half-watt miniature Sterilamp compresses a specially-designed tungsten filament, lead wires, and stem assembly into a walnut-size interior. The transformer required to step down the household electric voltage to the 12-volt lamp consumes only three and one-half watts. At least a year's life is assured for the lamp because its filament glows only for three seconds, insufficient to attain incandescence, each time the lamp burns. The filament serves as a starter for the arc which, when struck in a mercury atmosphere, produces the ultra-violet radiation.

AIR DRILL

Gives Heavy-Duty Service Without Heavy Weight

AN AIR-powered, half-inch drill is described as built to the specifications demanded for heavy-duty, continuous-



Auxiliary handle shifts to any angle

production jobs requiring tool stamina and accuracy, yet is said to be 40 percent lighter in weight than ordinary drills of the same capacity. It is claimed that ample power is provided for stall-proof operation on most jobs of drilling, reaming, and countersinking.

The drill, made by Aro Equipment Corporation, is equipped with an auxiliary handle that can be located in any position around the nose of the tool. The handle threads into a shoe located in a ring on the nose housing. To locate the handle in a new position, the operator loosens the handle with a 1/8 counter-clockwise turn, moves it to the desired position, then locks the handle by a 1/8 clockwise turn. This feature saves time and increases the versatility of the tool.

A safety-throttle trigger allows start-

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

ing and stopping the tool with a minimum of effort, and controls the operation. Other features include heavy-duty ball bearings, rotors, cylinders, and gears made of alloy steels ground to precision tolerances, and a built-in automatic oiler. Drill speed is 1000 revolutions per minute, weight 6¼ pounds, overall length, 8½ inches

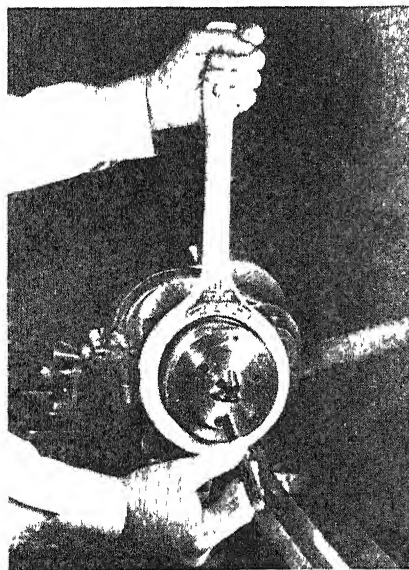
SPEED CHUCK

*Opens and Closes
Without Stopping Spindle*

A NEW, inexpensive high-speed chuck, intended to increase production and lower cost on short-run operations, is designed so that it can be opened and closed by slight movement of a handle without stopping the motor or spindle. If desirable to stop the spindle during operation, the handle can be used as a positive and efficient brake for instant stoppage.

The chuck, known as the "Standard-Hampton Speed Chuck," will compensate for spindle run-out and in most instances will allow close-tolerance chucking on any type lathe. Adaptable to fast, feed-through operations, the machine will permit chucking to full spindle capacity up to one inch.

For facing, threading, centering, drilling, or any turning operation, an adjustable spacer or stop accessory may be installed and used as an inherent



Adaptable to feed-through operations

part of the chuck. The jaws can be adjusted for close tolerance concentric or eccentric turning operations, and will hold any size or shape of bar stock within its minimum and maximum range, according to the manufacturers, Standard Tool and Gage Company, a subsidiary of Jack and Heintz Precision Industries, Inc.

PRE-FABRICATED RAFTERS

*Eliminate Load-Bearing
Partitions, Save Lumber*

A NEW type trussed rafter that saves up to 400 feet of lumber in a two-bedroom house is now being used in a number of houses under construc-

tion, and has only four basic members plus two scabs. There are no right or left-hand members.

The rafters can be fabricated at job site or in a shop with a minimum of equipment consisting of a cut-off saw and a portable or stationary drill and four simple patterns. Experienced labor is said to be unnecessary.

According to the developers, the Timber Engineering Company, there is no complicated notching and no spiking—which eliminates possible splitting. Ring grooves and bolt holes are cut in one operation and production-line methods can be employed. The method is adaptable to both single and multiple housing units.

Lumber savings are reported to be

accomplished by eliminating heavy bearing partitions and using non-bearing partitions such as light studs. Also there is less waste by pre-cutting and the ridge board is eliminated.

The rafters, pre-assembled on the ground, are erected as a unit, thus giving faster erection and affording interiors quicker protection from weather. A movable jig table speeds assembly so that rafters for one four-room house can be assembled by two men in an hour.

With standardized exterior walls, roof, and ceiling it is pointed out that any interior layout can be developed. The designer does not have to build rooms around bearing partitions as the partitions can be placed anywhere

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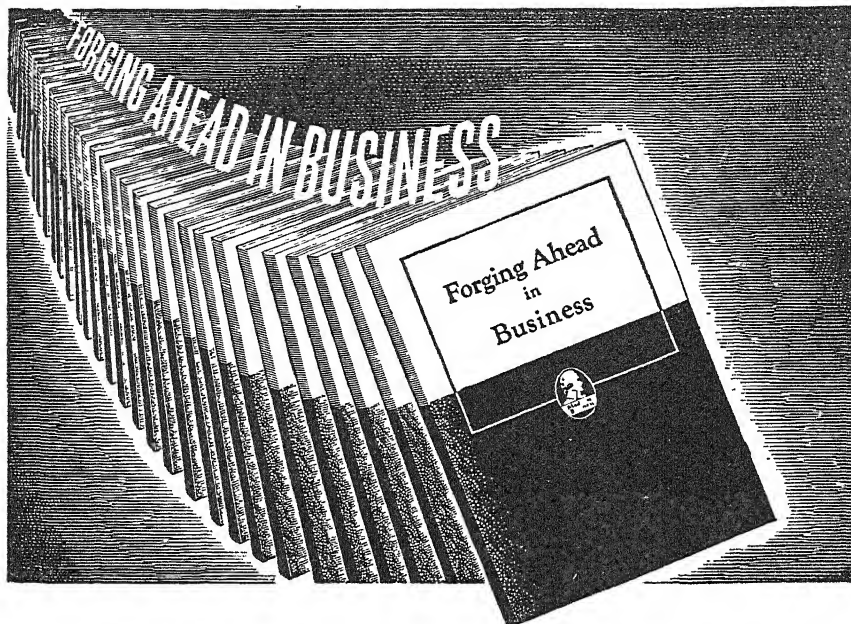
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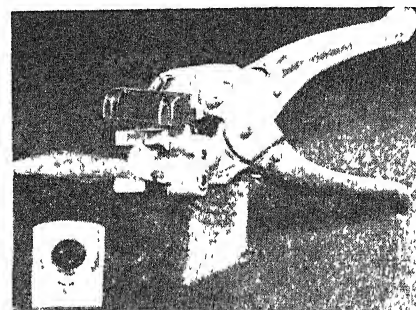
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without regard to ceiling framing. This flexibility makes it possible to provide three to six-room houses with the economy of standardized structural frame work. Here, prefabricated storage wall units will increase storage space in small homes without the expense of on-the-job framing of closets. The storage units form partitions but are moved into place after plastering.

TOOL ABRASION

Stopped with
Hard-Metal Inserts

A SOLUTION to the problem of securing satisfactory life of hand tools used under highly abrasive conditions can sometimes be found in the use of Carboly inserts. An example of such an



Jaws wear months instead of hours in holding parts for abrasive-brush job

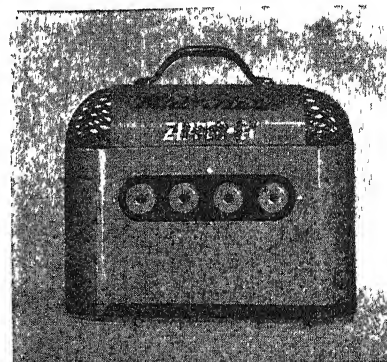
application is the brazing of two inserts to pliers used for gripping parts applied to a revolving abrasive brush. It is claimed that two months of continuous service caused no appreciable amount of wear on the hard inserts in the plier jaws, whereas plier jaws made from conventional materials would stand up for only four hours on the same job.

PORTABLE WELDER

Uses Standard Current,
Handles Most Light Jobs

RECOMMENDED especially for light-duty welding and general maintenance, a small, portable electric welder operates on 110-volt, alternating current. The manufacturer describes the welder, called Zipper-Et, as able to handle all maintenance and repair work that does not require the heavy-duty, industrial-type welders of high amperage.

The welder, complete with all accessories, is self-contained and has a



For general maintenance applications

total weight of approximately 40 pounds. A heavy-gage metal case with carrying handle provides portability. Also within the case is a transformer which is burn-out-proofed, with spun-glass insulation. It has a separate primary winding and a separate secondary winding, without any electrical connection between them. The manufacturer offers this point as an advantage over other welders which require a polarized-type plug and special care in welding grounded objects such as water pipes, radiators, and so on.

The accessories described include long cables with insulated taper plugs and sockets, a separate electrode holder and rugged ground clamp; aluminum, brazing, and steel welding rods, together with starting carbon and complete instructions. Also included as standard equipment is an arc torch which provides an electric flame, and an approved full-size helmet.

The Zipper-Et will accommodate five sizes of welding rod, from 1/32 through and including 3/32 inches, and will handle 1/8 inch carbons in the arc torch.

HAND LAMP

*Throws Spot or Beam,
Fixes to Cars or Boats*

PORTABLE and weather-proof, a new electrical hand lamp has a single focus adjustment whereby it will deliver a spread or spot light—the latter a brilliant 1500-foot beam. Powered by two standard drycells with pressure type connections, the unit weighs approximately five pounds.

A special feature is that the lamp may be set down anywhere or clamped in a



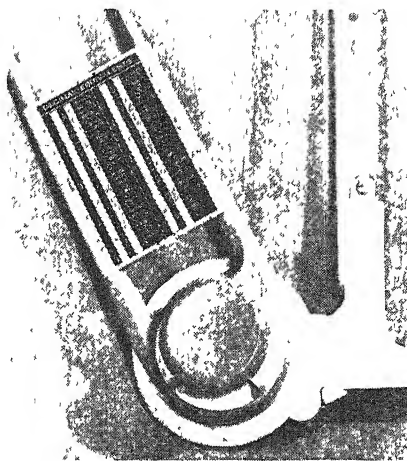
Uses two dry cells, weighs five pounds

special hold-down fixture accessory for automobile trunks or prows of boats. In addition to sportsmen, motorists, and other personal users, industrial, commercial, utility, and emergency organizations are expected to find the Big Beam light convenient. The maker is the U-C Lite Manufacturing Company.

DECIMAL CHART

*For Draftsman's Reference,
Fits on Drafting Machine*

IN TENDED for attachment to standard types of drafting machines, an etched-aluminum chart of decimal equivalents



Errors made in decimal conversion are reduced by this easily attached scale

is a new convenience for engineering workers.

The chart proper is three by five inches, has large legible lettering, and is protected by a durable Alumilite finish. Edges are formed to snap over the two parallel tubular support bars on some drafting machines, and garter spring attachment is provided for the single center bar machines.

When mounted on the machine, next to the protractor head, the chart is in position for constant ready reference. Less fatigue for the draftsman, reduced chance for error in decimal conversions, and a higher work output are among the advantages in the use of this chart.

TILE AND BRICK SAW

*Eliminates Dust Hazard,
Can be Carried to Work Site*

A PORTABLE, dustless masonry saw for accurately cutting tile, brick, and concrete block on the job is described as bridging the gap between wood cutting and metal cutting. Built with a self-contained water supply system, the new masonry saw is said to gear tile and brick cutting to keep pace with bricklayers on the wall. Stair rakes, jambs, fountain niches, trim, and outlets are all handled and construction for heat-annealing ovens, sanitary dairy plant rooms, and similar jobs is speeded up.

The Champion saw, made by the Champion Manufacturing Company, combines many features which contractors, faced with such problems, required in high speed construction. Portability makes possible cutting tile, brick, glazed tile, and firebrick at the spot it is being used. This has been gained by mounting the saw, cutting platform, belts, and motor on a stand with removable legs, similar to an ironing board, which makes it easy to pull it through windows, inside kilns, and so on. Weight is held down through use of a new type electric motor of two horsepower weighing but 72 pounds.

To counteract the clouds of choking dust created by some saws, the new saw incorporates a self-contained water system, and a circulating pump belt-driven from the motor, which through a concealed nozzle sprays a fine mist over the cutting surface, both prevent-

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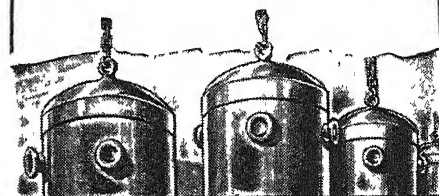
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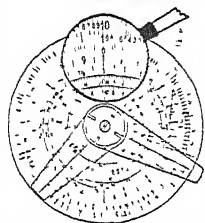
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ing dust and cooling the circular blade. The blade itself is provided in several degrees of hardness for various brick and tile products, including a diamond blade for cutting fine aggregates.

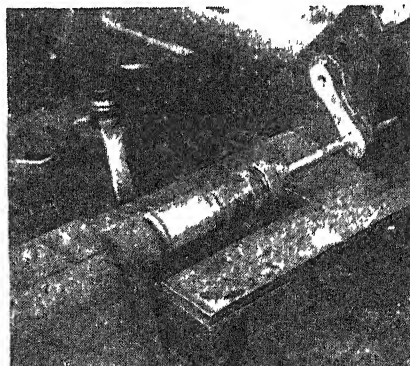
Another feature is reduction of operator fatigue. Whereas some masonry saws require the operator to push the tile being cut back and forth for a light, distributed cut, this saw is designed with a conveyor cart, which is pushed through with steady pressure. A spring oscillator on the blade mounting alternately applies and relaxes the cutting pressure. Thus only one operation is necessary after the saw is set and running. The oscillating action also eliminates the need for a foot pedal to apply pressure to the work, and the operator may stand any way desired and concentration of the water spray is splatter-proof.

Blades, chisels, marking pencils, hammers, and other pertinent tools are kept in a cabinet under the carriage of the saw.

DE-BURRING

Accomplished More Conveniently
With Permanent Set-Up

FOR USE in de-burring the stray edges around holes, Nobur Tools are generally used in the spindle of a drill press or a lathe. Recently, however, it was reported that an obsolete tool grinder base offers the advantage of a



Obsolete tool-grinder base rebuilt for use with standard de-burring tools

special de-burring machine always available for immediate use. This arrangement, in use at the Chain Belt Company, is claimed to have resulted in an increase in production and a substantial reduction in labor cost for de-burring operations.

TEMPERATURE CONTROL

Provides Visual Check
of Proper Functioning

A SIGNAL light, either red or white, glows brilliantly on a new mercury temperature regulator while temperature is rising, and shuts off when the setting temperature is reached. The glowing signal light can be seen at a distance, hence permits the operator to perform other duties and still determine at a glance when the temperature in a bath or oven has reached the desired temperature and when the regulator is operating properly.

Controls oven temperatures accurately

Called the Mercuroplat Thermoregulator, the unit is intended for accurate control of temperatures in water, oil, or air baths, ovens; and so on at any temperature within the setting range from minus 30 to plus 500 degrees, Fahrenheit. It has a sensitivity of plus or minus 0.02 degrees, Fahrenheit, or better.

The Thermoregulator is available in 6, 8, or 12 inch lengths, and its features include a machined plastics head whose design provides full visibility for setting, a convenient means for mounting, and an appropriate mounting for the signal light.

Contributing to accuracy and long life, is the distilling and filling method by which the mercury is distilled directly into the regulator without being exposed at any time to atmospheric air, thus providing higher purity of mercury. The Mercuroplat Thermoregulator is made by the Washington Glass Laboratory and Instrument Company.

ALUMINUM TOYS

Feature Lightness,
Durability, Ball Bearings

EXPANDING applications of aluminum fabrication are exemplified in a new line of all-aluminum bicycles, scooters, and other playthings. Of these, perhaps the greatest interest surrounds the cycle, called the Park-Cycle. Its total weight is only 19 pounds, or about half the weight of similar cycles fabricated of conventional materials. The aluminum used in the frame will not rust and is finished with baked enamel in several available colors. Other features of the cycle include wheels of



Total weight 19 pounds; will not rust

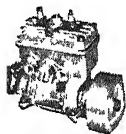
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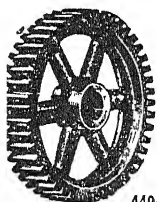
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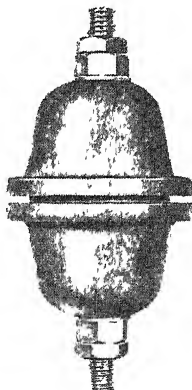
Also featured by a division of the Reynolds Metals Company are all-aluminum scooters and wagons. Still undergoing final tests, it is reported, is an all-aluminum bicycle engine.

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transformer bushing with excellent dielectric properties and small bulk is designed of the same material for high-voltage secondary leads of transformers used in neon signs, cold-cathode lighting installations, oil-burner ignition systems, and similar applications.

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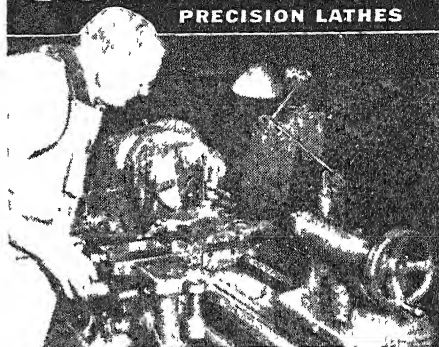
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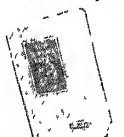
COLD-run and fast-setting, a new resin wood glue is claimed to be the only type of resin glue that can be handled and machined after 20 to 30 minutes clamping time, instead of the usual six to eight hours. Called Wood-Lok, the manufacturer, National Adhesives, advises that the glue produces a strong,

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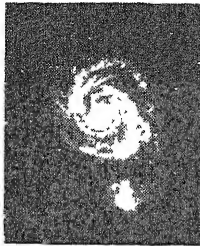
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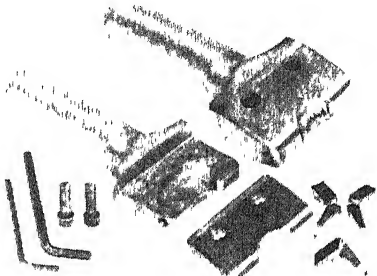
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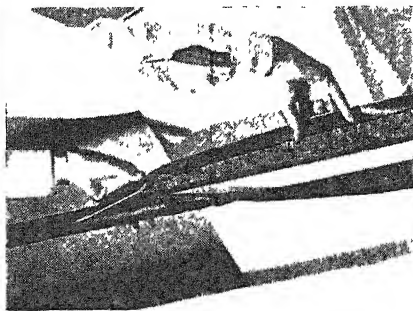
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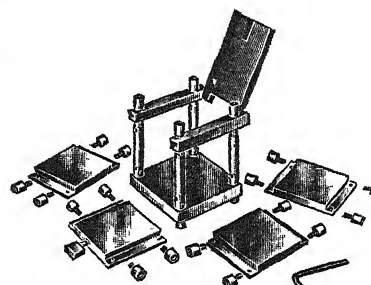
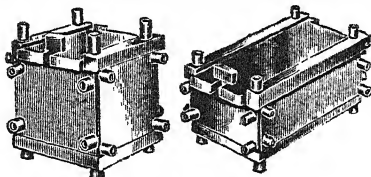
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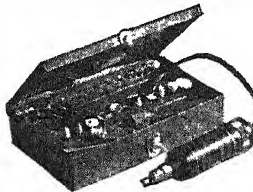
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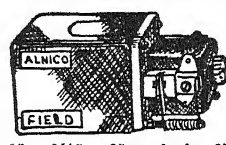


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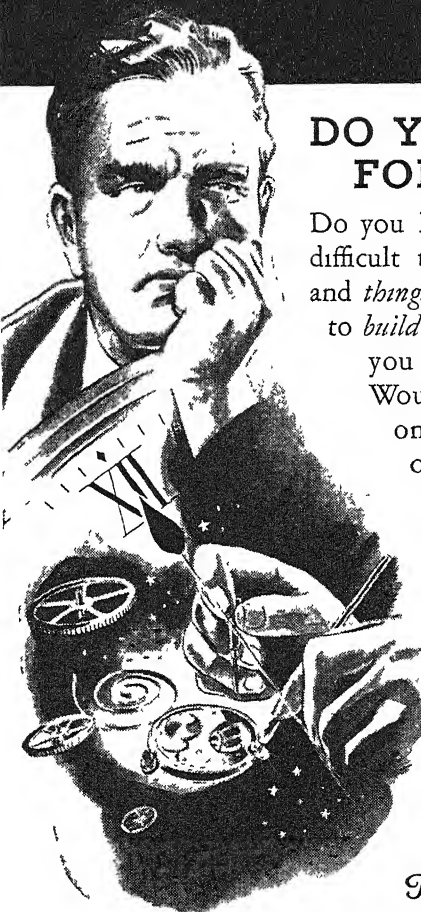
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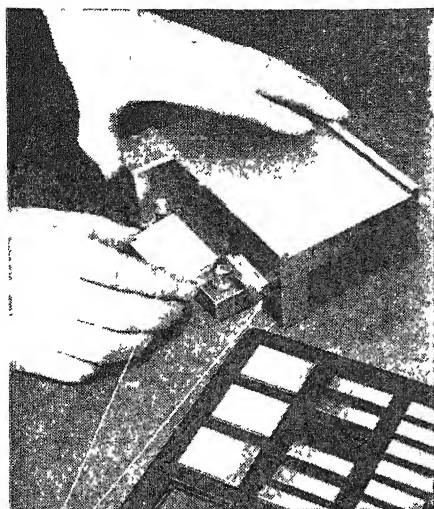
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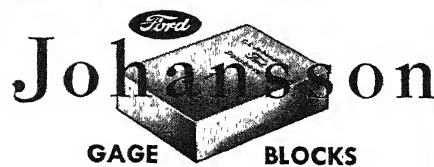
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The Editor

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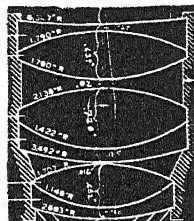
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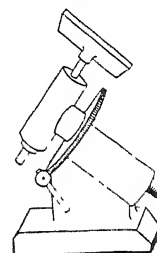
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TWO FEATURES of a 12½" reflecting telescope built by Edward Lenard, 4854 N Austin Ave., Chicago 30, Ill., deserve close study by readers who plan second or subsequent telescopes. These are the mirror cell and the focusing arrangement for use in celestial photography.

The mounting (Figure 1) is temporary. Its axes are close pipe nipples pivoting in standard pipe flanges.

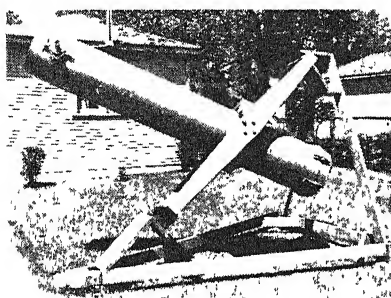


Figure 1. Lenard's 12½" reflector

The tube is 15½" by 93", for a 12½" Pyrex mirror of 92½" focal length. It was rolled up from sheet aluminum designated as 3S½H 065 (3, alloying composition, S, wrought, ½H, one-half hard; 065, thickness in inches), a grade which takes welding well. However, the three lengths composing the tube are riveted together. The tube is braced internally by four U-channels formed in a hand brake and then bent to diameter over various round objects. "The reasons I chose aluminum," Lenard writes, "are its very desirable working properties, resistance to weather, heat-conducting qualities, reflectivity, and strength-weight ratio. It is somewhat expen-

sive. However, it makes a pretty tube."

The cell and attachments (Figures 2 and 3) are made of the same sheet stock. Within the cell is a 9-point flotation system carried on a spider of six legs bent from sheet and welded at their common center.

To three of these spider legs are attached short brass blocks through which three bolts (SAE ½-20) pass and are tightened up by nuts on the outer sides.

Silver-soldered to the ends of these three bolts are ⅝" ball bearings. These balls are pressed into the ⅛" triangular, aluminum, 3-point plates which carry the mirror, and the depressions serve as the primary pivots. Bolted through the corners of the respective plates are 3/16" brass bolts on which, as secondary pivots, the mirror is carried.

Such a system will float a mirror but the triangles would soon become turned in different directions and destroy the intended distribution of weights. Some kind of preventers therefore must be provided and these must not interfere with the actual balancing. Lenard's sys-

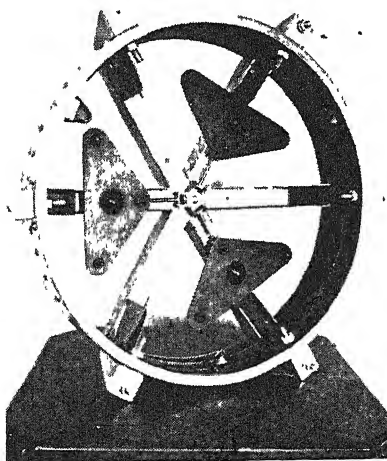


Figure 3: Same cell from above

tem consists of three links, each with a T-head on either end and the ends of the T's pivoted at the central hub of the spider and at one of the triangular plates. This affords them freedom in the up-and-down plane (one degree of freedom) but there must also be a little end play and thus two degrees of freedom are needed. Lenard has provided this by composing the stem of each link of two small brass tubes, one telescoping within the other. He points out, however, that for ideal performance a ball-and-socket joint should be substituted at the triangle

end and makes a comparison with a ship, where the motions are theoretically either pitching or rolling but usually are a composition of the two—yawing. Theoretically, he points out, the linkages should permit yawing.

As edge supports for the 12½" mir-

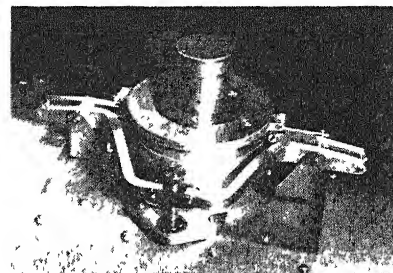


Figure 4 The focusing mechanism

ror the ends of the six filister-head machine screws shown in Figure 3 suffice. "The inclined mirror then has two points to rest on in any position and in some positions three," Lenard states, "though the lower one in such cases takes most of the weight."

To prevent the mirror from falling out of the cell when the tube is dipped below the horizontal, three simple retaining fingers having little leather pads reach around its edge.

Lenard's focusing arrangement is shown in Figures 4 and 5. He states that perfect control is here not easy to attain. "The problem of raising and lowering the barrel without rotation and without sticking was solved," he

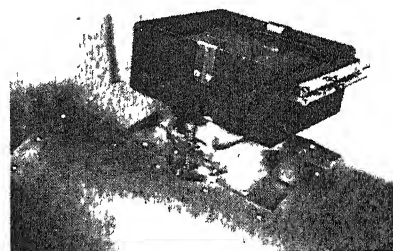


Figure 5: Focusing the camera

states, "by using at least two points to which to connect the hinge. This arrangement comes up and down evenly and without sticking, and affords very fine adjustment as well. The single thumbscrew actuates the whole system. The travel of the barrel is not more than ⅝". I use various lengths of brass tubing to suit the focal length of each eyepiece and changing over thus does not require refocusing. [Parfocal. —Ed.] The reason for countersinking the assembly is to permit mounting a Packard shutter directly below, on the inside of the tube, for photographic work. This shutter is operated by a bulb. The entire assembly was made by hand from brass and aluminum."

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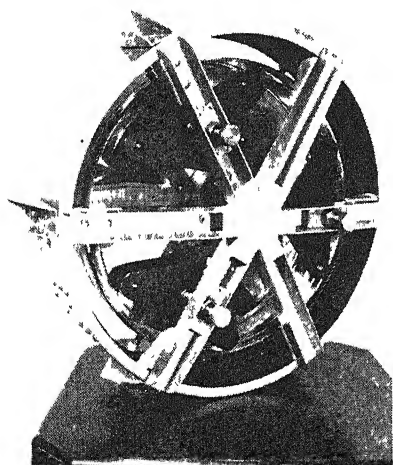


Figure 2: The cell from below

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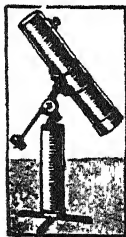
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6" Kit	4.50	Pyrex, 6.00
8" Kit	7.50	Pyrex, 10.00
10" Kit	12.50	Pyrex, 17.50
12" Kit	18.00	Pyrex, 25.00

PRISMS 11/16" \$2.50, 1¼" \$3.75, 2" \$7.50
Pyrex speculums made to order. Your mirror tested free. We do polishing and parabolizing.

ALUMINIZING

A harder and brighter aluminum coating that is uniform and produces a lasting and superior reflecting surface. Guaranteed not to peel or blister.

6"	\$2.50
8"	\$3.50
10"	\$5.00

Mirrors for Cameras, Range Finders and other optical instruments.
Write for FREE PRICE LIST

THE PRECISION OPTICAL CO.
1001 East 163rd Street, N. Y. 59, N. Y.

one of their metal molds and from this a reproduction draftsman redrew Figure 6, which should be studied in detail before reading on. It explains a number of things which make sense once you are shown their reasons.

Now let's cast a blank. The plunger is raised and the ring is lifted off. The workman, known as the "gatherer," pours into the mold a gob of molten Pyrex. This is not like water but viscous, molasses in January, even at 2800° F., its softening point. Now he claps on the heavy ring part and down

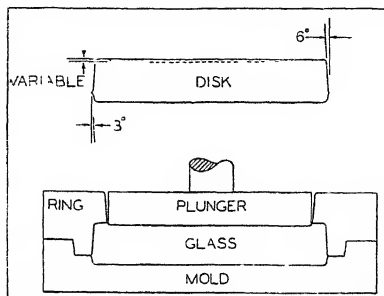


Figure 6 Molding Pyrex blanks

comes the plunger. It is nice if, when the plunger is all the way down and the mold is filled out, the plunger bottom comes to rest as shown—very near the level of the rim. Making it so depends on the estimative skill of the gatherer and he is very good at this knack but is only human. If it is a bit over or under he can't add more Pyrex with an eyedropper; it's too viscous. Get it hotter? Easier said than done. The softening point of Pyrex is already much above that of common varieties of glass.

The molded disk is removed from the mold very soon and turned over. Its exterior is already relatively cool but its interior, seen through the glass, is still red hot. As this interior cools the center of the wider face of the disk falls a little and this explains the slight concavity usually found on Pyrex blanks.

The 6° tapered side is the draft, so that the ring can be slipped off—see the drawing, which also shows a 3° draft on the part that lies in the mold.

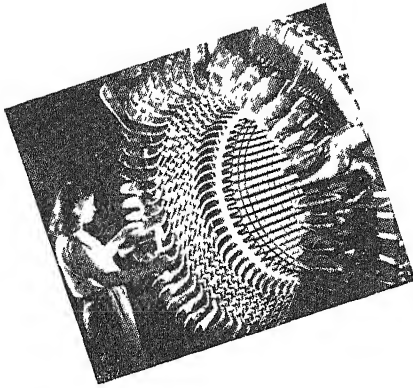
Visit Corning Glass Works and you may be shown several shelves filled with these heavy metal molds.

The bubbles often found in Pyrex blanks would rise and escape if Pyrex were not so viscous. The bubbles you don't see are the bigger ones that were able to escape. Little ones can't rise so easily. Case of surface-volume ratio. No practicable way to eliminate all the bubbles is known. Corning would be glad to find one but it isn't as if they hadn't given the problem a great deal of thought.

SEQUELAE of the seldom curable telescopic addiction are sometimes serious, and may even include outbursts of light verse. The following is how the hobby affected M. J. Irland, 916 N. Rosevere, Dearborn, Mich. He entitles it "Paradise Lost, or Ignorance is Bliss," and dedicates it to your (blissful) scribe:

There was a man in days gone by
Who loved to watch the skies
He'd learned the constellations well,
With his unaided eyes.
He bought a book called "A.T.M.,"
A first edition slum,
And set to grinding disk on disk
With diligence and vim.
With windshield glass and pocket lens
The optics he completed,
And learned to silver Brashear's way,
Through trials oft repeated
With joy he gazed at Saturn's rings,
Made lunar observations,
Watched Jupiter's bright satellites,
And noted occultations.
Then "Telescopics" told of tests
On Lyra's double star;
He drooped with disappointment when
He couldn't split Mizar.
So back to Carbo, glass, and pitch
He turned in wounded pride,
With "A.T.M." (edition two)
Well rouge-stained, by his side
With slits and Ronchi gratings, culled
From Telescopics' pages,
He strove to get the doughnut shape
Commanded by the sages.
Came "A.T.M."—edition three—
With Greg and Cassegrain;
Our hero could not well ignore
This challenge to his brain
On Hindle sphere, paraboloid,
And convex hyperbolic
He lavished rouge, and sweat, and tears,
In frenzy diabolic.
Edition four, with bottlenecks
In declination shafts,
Impelled him in despair to learn
All metal-working crafts.
But when he thought he'd made a 'scope
Without an imperfection,
"A.T.M.A." depressed him into
Deep and dark dejection.
For there he found expounded,
As a matter most essential,
New doughnut mathematics
In equations differential.
So, weary but undaunted, he
Performed manipulations
For testing astigmatic curves
And spheric aberrations.
At setting circles, clockwork drive,
And domed observatory
He labored with the fury of
A fiend from Purgatory.
But when he'd run the gamut, in
The hope of satisfaction,
Infinitesimal defects
Still drove him to distraction.
No longer did he scan the skies
To revel in their beauty;
Detecting telescopic faults
Was his fanatic duty.
Instead of watching clusters for
The pleasure of their glitter,
He studied star diffraction rings,
Despondent at their jitter.
The seeing made him grind his teeth,
Air currents plagued his vision.
No collimation could attain his
Notion of precision.
And as he sat with head in hands,
Bystanders heard him mutter:
"I'm gonna junk the whole dam' works
And throw it in the gutter."

The moral for beginners is:
Lest knowledge disconcert you,
Recall the aged maxim, viz.,
What you don't know won't hurt you.



INDUSTRIAL DRAMA One stage in the construction of a 43,750 KVA Westinghouse turbo-generator, capable of supplying the electrical requirements of a community of 35,000 population

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50 Years Ago in . . .



(Condensed from Issues of November, 1896)

INVENTIONS VS LABOR — "It is no doubt true that when a new invention is introduced which revolutionizes some particular art or branch of business, it at first decreases the number of persons employed in that particular line, but that is only temporary, for in a short time the result is a cheapening of the product, a greatly increased demand for it, because of this cheapening, and then necessarily an increased demand for laborers in that line, and almost universally at increased wages. Statistics show this to be true beyond the possibility of a question."

SCIENCE CO-OPERATION — "The time is certainly ripe for the establishment of a great international association for the advancement of science. The various national associations have shown by their recent fraternal exchange of courtesies that they are prepared for it and are fully alive to the benefits which it would confer."

HORSELESS CARRIAGE — "The horseless carriage herewith illustrated is a compact and well proportioned vehicle which has been giving good service during the past few weeks on the country roads of Michigan. It is driven by a five horse power gasoline motor which is placed underneath the box. In attaching the motor to the carriage, care has been taken



to avoid any direct attachment to the box, so that when it is running the vibrations shall not be communicated to the passengers . . . The fuel supply is located below the engine and has no connection with the box, special care being taken to prevent any possibility of explosion . . . The carriage was invented by Mr. R. E. Olds, the general manager of the P. F. Olds & Son Engine Works of Lansing, Michigan."

WIRED GLASS — "Some tests recently made to determine the fire resisting qualities of wired glass, i.e., glass containing in its texture woven wire netting . . . showed that glass of this kind is capable of withstanding a high temperature, very much higher than ordinary glass, without melting or losing its continuity, even when suddenly drenched in a heated state in cold water . . . The capability of the wired glass to withstand a temperature beyond the melting point of glass appears to be attributable to the fact that the network of wire in the glass acts as a good conductor of heat, and thereby prevents the accumulation of sufficient heat to melt the glass."

WASHING MACHINE — "A machine designed to rapidly force the washing liquid many times through the clothes with the least possible expenditure of labor or power, and without

danger of injury to the clothes has been patented . . . The water is forced through the clothes by reciprocating perforated plungers or dashers whose squared shafts slide in and turn with the hubs, there being on one of the hubs a pulley to be connected by belt with a source of power, or the machine may be operated by hand."

SIAM RAILROAD — "With the exception of the short narrow gage line to Paknam, the railway now under construction from Bangkok to Khorat is the only railway in Siam. It is to be the first of a vast ramification of lines designed to distribute civilization to the most distant portions of the kingdom."

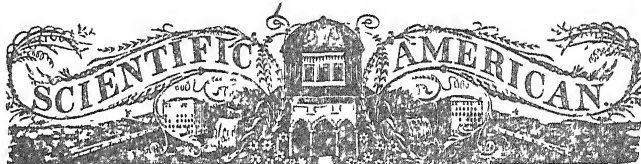
TESTING — "No more valuable move has been made, of recent years, by our railroads, than a recognition of the fact that it was necessary to know accurately the character of the material they were using, both in track and rolling stock, so that at the present time all first-class roads either have a testing bureau, as a special department of their own organization, or employ one of the numerous testing bureaus."

BRANDY — "The largest brandy still in the world is at El Pinal vineyard, in San Joaquin County, not far from Stockton. Part of it has been built about four years and the other part was finished only a short time ago. The grape juice or wine is pumped from vats to a tank. From there it simply passes through a series of heated chambers in the form of a vapor and comes out in the shape of brandy. . . From the time the wine leaves the tank until it comes out as grape brandy only ten minutes is occupied. In the old method of distilling it used to take about three hours."

BRIDGE CARS — "The new electric motor cars to be operated on the Brooklyn Bridge, and which are to take the place of the old switching engines, are being tested, and so far have proved successful."

OIL — "More than 2,700 oil wells were bored in Indiana in 1895, and hopeful, well informed men expect that enormous total will be surpassed in 1896. The oil industry of Indiana is coming to be one of the greatest in the State, and it is confidently predicted in some quarters that the State will soon rank with Pennsylvania and Ohio in the quantity of oil annually taken out of the ground."

100 Years Ago in . . .



(Condensed from Issues of November, 1846)

TRANSCONTINENTAL — "There has recently been a large meeting at the room of the Board of Trade, Pittsburgh, to hear an explanation, from Asa Whitney, Esq., of his project to connect the Atlantic and Pacific Oceans by railroad."

WORKING CONDITIONS — "A factory has been established at Bradford, England, to be conducted on an improved system. The operatives are required to work only ten hours, and with the factory are connected an excellent school and other means of instruction, with improved wholesome accommodations for boarding, lodging, &c."

BUILDING — "In the course of eight months, not less than twenty-five hundred brick houses have been erected in Pittsburgh, including many noble and costly factories."

PRINTING PRESSES — "We are satisfied that there is yet an open field for improvements in printing presses, and should not be surprised to see one introduced, by which the pressman can operate the machinery by double treadles while his hands are employed in feeding the machine."

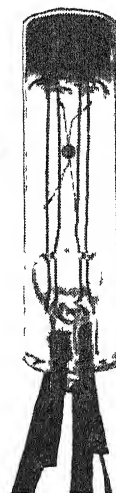
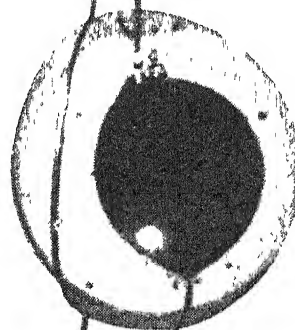
The Eye That Never Closes

You are looking at a thermistor — a speck of metallic oxide imbedded in a glass bead hardly larger than a pin-head and mounted in a vacuum. The thermistor was developed by Bell Telephone Laboratories to keep an eye on the amplification in long-distance telephone circuits.

When a thermistor is heated, its resistance to electric current changes rapidly. That is its secret. Connected in the output of repeater amplifiers, it heats up as power increases, cools as power decreases. This change in temperature alters the resistance, in turn alters the amplification, and so maintains the desired power level. Current through the wire at the left provides a little heat to compensate for local temperature changes.

Wartime need brought a new use for this device which can detect temperature changes of one-millionth of a degree. Bell Laboratories scientists produced a thermistor which could "see" the warmth of a man's body a quarter of a mile away.

Thermistors are made by Western Electric Company, manufacturing branch of the Bell System. Fundamental work on this tiny device still continues as part of the Laboratories program to keep giving America the finest telephone service in the world.



BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Previews of the Industrial Horizon

PATENTS STILL STYMIED

HEART of industrial America is the United States patent system. Upon the protection given by this system depends the incentive to invent, to improve, to progress. Yet, as pointed out on this page, September 1946 issue, the powers-that-be placed serious war-necessitated handicaps on the operations of the Patent Office and then, tortoise-like, moved but slowly to remove them.

Our September note called attention to the wide separation of parts of the Patent Office. Since those lines were written, announcement has been made that the units in Richmond will be moved closer to the Washington units—within three and a half miles, to be exact. But this is not enough. Essentially the operations of the Patent Office must be on assembly-line principles if peak efficiency is to be realized. Even with the latest move, the examining divisions will still be separated; the shuttling of papers, examiners, and inventors will continue. Try this system on an industrial production line and watch output decrease. That is exactly what has happened with the Patent Office. Latest official figures show that over 114,000 patent applications are awaiting action—not the mere 11,000 mentioned in our September item as the result of an errant typographical figure.

For the sake of emphasis we repeat: The Patent Office must be consolidated, returned to its pre-war efficiency. An approach to such consolidation is not enough; the physical consolidation must be complete if our patent system is once more to function properly.

LOCOMOTIVES IN PRODUCTION

SPEAKING of the Patent Office as a production-line operation brings to mind the first mass-production plant for locomotives just put into service by the American Locomotive Company. Up till a couple of months ago, locomotives were assembled by the gang method: Materials and men were concentrated at one point where the behemoth of the rails gradually took form. Now, under the assembly-line procedure, the unit proceeds along the line, with sub-assemblies being made in shop bays. These bays, in turn, feed the main line so that complete locomotives emerge at the end.

Formerly it was thought that locomotives were too large, too bulky, to lend themselves to assembly-line construction. But the mechanics of the job have been worked out. They point toward a broader expansion of the underlying principle of increased efficiency through stabilization of worker position and wider application of conveyors of one type or another to carry the assembly from point to point as parts are added.

INCREASE PRODUCTIVITY

OUR EDITORIAL forte is applied technology but all too often the ideals and aims of the technologist become inextricably involved with human nature. Strikes of the moment are a case in point. Perhaps we over-simplify

By A. P. Peck

—but over-simplification is frequently refreshing in the welter of conflicting and selfish opinions—when we point to the basic premise that increased productivity of the individual industrial worker would automatically put an end to practically all of the disputatious points which breed strikes and industrial unrest. Still over-simplifying, it seems that labor in general wants to produce less for more wages. This just doesn't make sense. Productivity—not money—is wealth. The tools are there. The industrial plant is there. Management is willing. Technological knowledge is available. Only human nature—and a disregard of the principles of economics—stands in the way of increased production and consequent increased wealth of the nation as a whole.

BETTER SURFACE COATINGS

STILL in the experimental stage, but pointing inexorably toward a new horizon in the surface coating field, is the work that is being done by General Electric with silicone paints. The whole field of silicones, in fact, holds increasingly great promise. These inorganic materials, with excellent temperature and corrosion resistance characteristics, as previously reported in these pages, are making their impress on many fields of industry, ranging from elastomers to lubricants to plastics to paints.

But to get back to the silicone surface coatings: Extensive service tests of silicone paints indicate that they will give virtually "life-time" finishes to such durable goods as automobiles, refrigerators, stoves, furniture, industrial machinery, and the like. The coatings will withstand temperatures from far below zero to over 550 degrees, Fahrenheit, without losing their luster or changing color. Silicone paints promise as great a revolution in the surface-coating business as was brought about by the nitro-cellulose lacquers in the early '20s.

STRAWS IN THE WIND

WHILE pre-fabricated houses may some day become an important factor in the low-cost housing field, present cost of these houses in general is no lower than conventional homes. . . Micro-filming, plus punch-card filing, promises high efficiency and compactness for industrial files. . . Premiums of all kinds, low in cost but high in human interest, are increasingly successful in promoting consumer goods. . . Home air conditioning will not get the reception it deserves until a better appreciation is reached by both manufacturer and user of all the problems involved. . . "Research," says Charles F. Kettering, "is the process of finding out what you are going to do when you can't keep on doing what you are doing now."

Brightening The Surface

Complete Assemblies, Intricate Designs, Wire Articles, and a Host of Other Mechanical-Buffing "Problems" Can be Electrolytically Polished at Low Unit Cost. Particularly Practical is the Facility with Which This Method Adapts to Existing Electroplating-Production Equipment

By FRED P. PETERS

Editor-in-Chief, Materials & Methods

EVER SINCE some siren of antiquity first found it both pleasant and useful to study her reflected beauty in a metal mirror, industry and the arts have aggressively sought new methods of producing lustrous, mirror-like surfaces on metals. Today, dazzling bright finishes are found not only on mirrors and on reflectors but also on hundreds of other articles where the appearance of the product rather than its functional reflectivity is the chief consideration.

For generations, mirror-bright surfaces on jewelry, cutlery, silverware, and so on—and in modern times on cocktail sets, golf clubs, windshield wipers, and other impedimenta of civilization—have been produced by mechanical polishing or buffing methods. Often these operations are an aftermath of electroplating, the general procedure being to produce the brightest possible plated surface and then to finish this surface to a brilliant luster by mechanically or manually rubbing the surface against wet or dry polishing cloths, buffing wheels, impalpable abrasive powders, and similar materials.

Recently, a new technique, electrolytic polishing—or electropolishing, for short—has come into in-



Courtesy Rustless Iron and Steel Division, American Rolling Mill Company

Intricate stainless-steel jewelry is made possible by electropolishing methods

creasing use for parts or products that are relatively difficult or expensive to polish effectively by conventional methods. Electropolishing also has certain advantages of its own which make it competitive with mechanical polishing for some types of work, although for other jobs the orthodox buffing or polishing methods may sometimes be simpler or more economical.

Electropolishing is, in a sense, electroplating in reverse. The part to be polished is placed in a suitable solution where it functions as the anode—rather than the cathode, as in electroplating. A cathode of some other conducting material completes the cell. When the electric current is passed through the part, acting as the anode, into the solution, a thin film of metal is removed from the

being garish; economical application to certain products, parts, and shapes such as wire forms that are difficult to polish economically otherwise; and the production of bright finishes in corners, holes, spiral grooves, knurled surfaces, and other inaccessible portions of metal parts. The latter locations are often almost impossible to reach by mechanical polishing or buffing methods.

The process also has other advantages or purposes that are as yet of lesser importance. Some of these are its ability to remove burrs or sharp edges, the slightly improved corrosion resistance it effects in some metals, its applicability for electrolytic "machining"—to remove a microscopic layer of metal for dimensional reasons, or to improve surface smoothness—and its faculty

• LOOKING AHEAD •

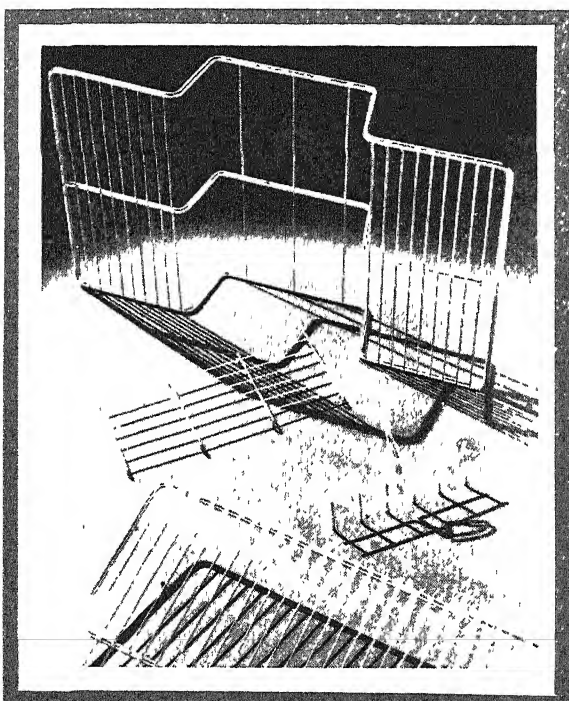
Greater design freedom — decoratively, functionally — with limitations of mechanical polishing eliminated . . . Many-fold expansion of electropolishing installations . . . More electrolytic "machining" on extreme-precision products . . . Increased use of welded-wire construction.

of revealing seams or irregularities in a surface that might otherwise remain hidden.

TWO METHODS COMMON—Commercial electropolishing has been applied primarily to stainless steels, for which it is economically in a better competitive position than it is for some of the other softer, easier-to-buff metals. It is, however, increasingly used for other metals and alloys, and some new and interesting processes for these have recently been developed.

For stainless steels the electropolishing process most widely used in this country is the patented citric-sulfuric acid process of Rustless Iron and Steel Division of American Rolling Mill Company. The sulfuric-phosphoric acid process, patents on which are owned by Battelle Development Corporation—an affiliate of Battelle Memorial Institute—though less used on stainless than is the Rustless process, has been used commercially on a host of other metals as well, and thus has special interest because of its versatility.

The Rustless process for stainless steel employs a solution of 55 to 60 percent citric acid, 15 percent sul-

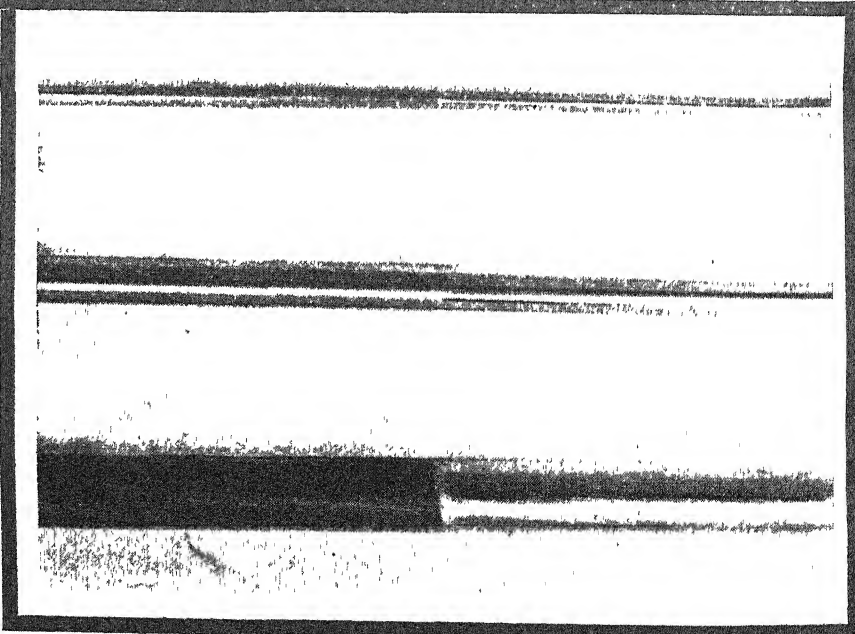


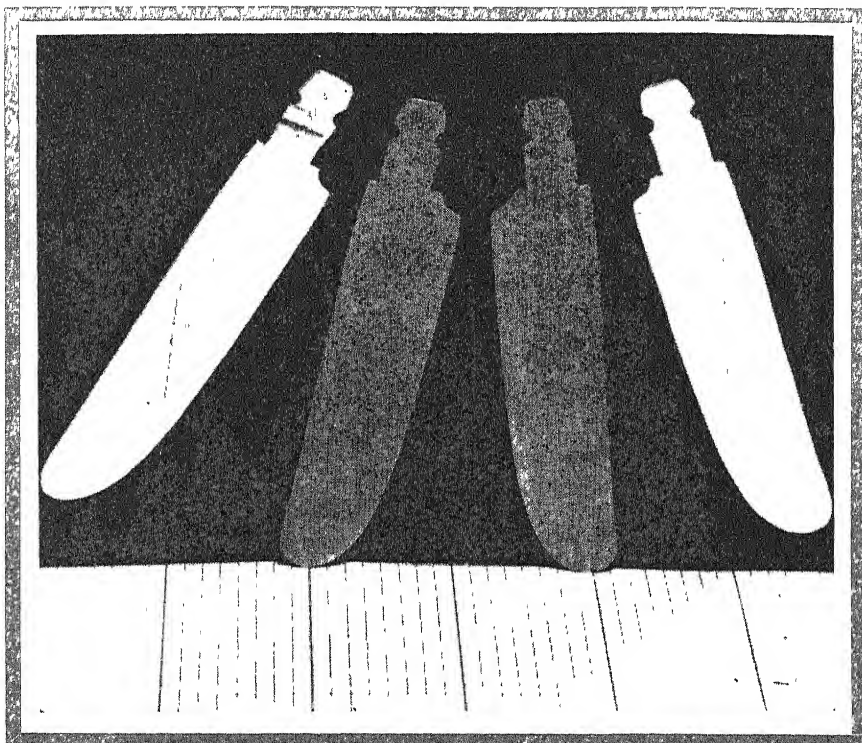
Refrigerator shelves (left) of welded stainless-steel wire, almost impossible to polish manually, gleam brightly after quick electropolishing treatment. Samples of wire used (below) show dull unpolished surfaces on left; ends on right have undergone electropolishing. Illustrations courtesy Rustless Iron and Steel Division, American Rolling Mill Company

surface of the part—in electroplating metal is added to the surface.

The normal surface of a piece of unpolished metal consists of microscopic hills and valleys. In electropolishing, the passage of current tends to remove more metal from the hills than from the valleys, and this leveling effect is responsible for the increased brilliance. The longer the operation is continued—up to a certain point—the more level and the brighter the surface becomes. Electropolishing is susceptible to close control and has been as successfully used for precision industrial work as for the production of surfaces remarkable for their beauty alone.

Electropolishing features that appeal to many users include finishes that are pleasingly lustrous without





tropolished on the same racks on which they are electroplated.

Indeed, the applications of electropolishing to already-plated metal represent one of the most promising fields for the new process. In such instances, electropolishing often eliminates a hand-buffing operation, since it can be performed automatically in tanks on the same production line as the electroplating tanks. This was found especially valuable in the case of one electric appliance parts manufacturer, for example, who forms certain parts out of cold-rolled steel, bright-nickel-plates them, then electro-buffs—instead of mechanically buffing—and finally chromium plates the parts, achieving an entirely satisfactory and attractive chromium finish with a cost saving of one to five cents per unit.

Another likely application for electropolishing is for costume jewelry. Intricately shaped brass parts may be electropolished prior to plating them with a thin coating of

furic acid, and the balance water. Operating conditions depend on the composition, surface characteristics, size and shape of the steel, amount of luster desired, and other factors. Direct current at 6 to 12 volts, and current densities of $\frac{1}{2}$ to 1 ampere per square inch are used, bath temperatures being held between 185 and 200 degrees, Fahrenheit.

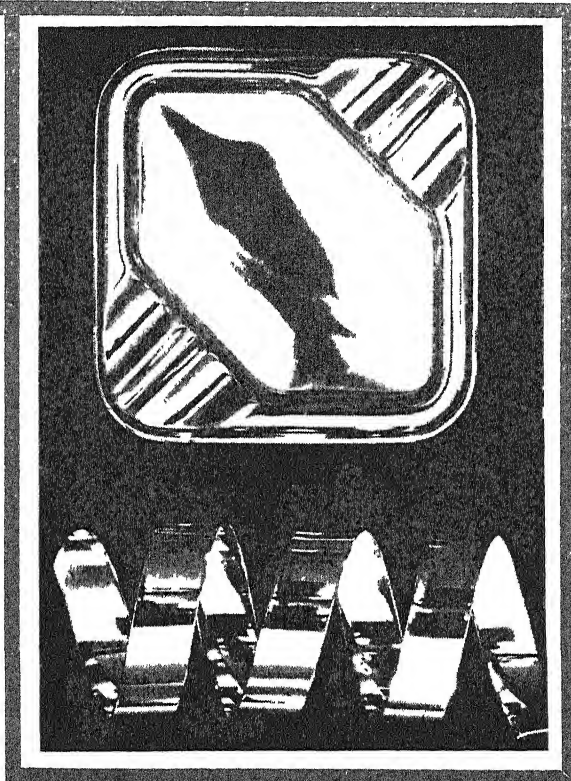
The time of immersion necessary to achieve a specified luster varies with the original surface and the current density. Even one minute is sufficient to improve the luster, but five- to ten-minute periods are usually required to produce full luster on initially smooth work. Rough surfaces may take 10 to 15 minutes. An important point is that electropolishing by any process will brighten a bumpy or coarsely rough surface, but it will also leave it still bumpy; the degree of smoothness of an electropolished finish is related to the smoothness of the original surface.

The Battelle solutions, using mixtures of sulfuric and phosphoric acids, are of considerable commercial interest because they can be applied to the electropolishing of many common materials—carbon steel, alloy steels, stainless steels, aluminum, brass and, to a limited extent, zinc, copper, nickel silver, and other alloys without changing the solution or with simple changes in the proportions of the constituents.

POLISHING COSTS CUT — Silver has recently been added to the list of metals that are being commer-

Silverware industry finds source of economy and product improvement in electropolishing.

Knife blades in outer positions (above) show results that are possible without mechanical buffing. Decorative items (right), too irregular for economical hand buffing, polish up as well as the simpler knife blades when electrolytic methods are used. Illustrations courtesy Battelle Memorial Institute



cially electropolished through the separate development by Westinghouse (Scientific American, September 1946) and by Arthur D. Little, Inc., of alkaline processes applicable to this metal. The Arthur D. Little process, which employs an alkaline cyanide bath similar to that used for plating silver, has been used for over a year by Oneida Ltd. on silver tableware with notable improvement in quality and reduction in operating cost. A special advantage of this installation is that spoons, forks, knives, and so on can be elec-

gold, which may or may not require a final light pass on a coloring wheel. For cheap or novelty costume jewelry the gold plating may be omitted and the item simply finished brilliantly in electropolished brass, at a total production cost often as low as one half cent per piece.

COMPLEX PARTS POLISHED — An exceptionally intriguing use for the process which recently received much publicity is for stainless-steel jewelry. One novelty jewelry manufacturer does a rushing business

producing bright and shiny electropolished stainless bracelets, earrings, belts, jewelry cases, watch bands, chokers, hair-bands, and similar articles. These he makes from stainless-steel wire by braiding it, forming and twisting the heavy braids, cutting, welding where required, and electropolishing to give a brilliant finish. Electropolishing actually makes this application possible, for it is the only method capable of producing a brilliant luster on all the loops, crevices, and interstices of the braided metal.

The electropolishing of stainless-steel refrigerator shelves made of welded wire and strip is one of the outstanding applications of this process, and was the first to be accomplished in large commercial volume. Here the process is not only highly economical—because of the much higher cost of polishing wire forms mechanically—but also serves to remove the weld discoloration that was virtually impossible to obliterate mechanically. One large, semi-automatic installation of the Rustless process for this purpose produced up to 5000 electropolished trays per day.

A good example of the versatility of the Battelle process is its use, after assembly, for electropolishing an automobile windshield-wiper arm which combines in the assembled unit stainless-steel stampings, carbon-steel extension bars, inserts and springs, and brass parts. Excellent overall finish is obtained by electropolishing the assembled unit for two minutes in one bath, at the rate of 750 per hour. The same tank also electropolishes 3750 wiper blades per hour and the average electropolishing cost is about one half cent per piece.

Again, refrigerator ice-cube trays of aluminum are electropolished after forming, the inside and outside of the trays being done simultaneously at an electropolishing production cost of around three cents per tray. In the case of electropolished aluminum reflectors, light reflectivity—especially to ultra-violet light—is reported to be better than that of mechanically polished aluminum reflectors.

At the present time there are more than 100 commercial or pilot-plant electropolishing installations in operation. The companies involved include large and small manufacturers; the installations are of all types including automatic, semi-automatic, batch, and hand-operated; and the materials and forms handled run the whole gamut from stainless steel, through aluminum, down to carbon steel, in the form of forgings, stampings, cast-

ings, bar, rod, wire, sheet, and fabricated parts.

But this is only the beginning, for many companies hitherto watching from the sidelines are about to install units, and at the same time important improvements in processes are ready to be introduced.



STAMPED MOTOR PARTS

*Replace Castings for
Light, Welded Unit*

MADE largely of steel stampings, a new electric motor will be proportionately smaller and lighter than conventional motors. Castings will be replaced by stamped and pressed steel parts welded together. Latest machining practices will be used and the power plant will meet all standard motor-design requirements.

UNIFORM METAL POWDERS

*In Ultra-Fine Grades,
Gain High Density and Strength*

FOR MOST commercial uses of powdered metals, the fineness of metal powders are precisely rated by giving mesh sizes down to -325 mesh—the powder that will pass through a sieve having 325 squares per square inch. Powders finer than this are usually not graded, simply being reported as -325 mesh.

This finest classification of commercial powders is considered unsatisfactory by many fabricators because of shrinkage and non-uniformity problems associated with it. Here, powder mixtures that pass through a -325 mesh are not just one size, but a mixture of sizes ranging all the way from 1 millionth

of an inch up to 44 millionths in diameter.

Dr. H. H. Hausner of New York University has recently demonstrated that the ultra-fine particles can be produced to a specified size such as two microns instead of a broad size-range and that two-micron powder has distinct advantages as to uniformity of processing behavior. Ultra-fine copper powder, in particular, permits the manufacture of larger powder-metal parts because the pressure applied per unit of area can be lower. In addition, uniform ultra-fine powders lead to parts of higher density, hardness and mechanical strength.

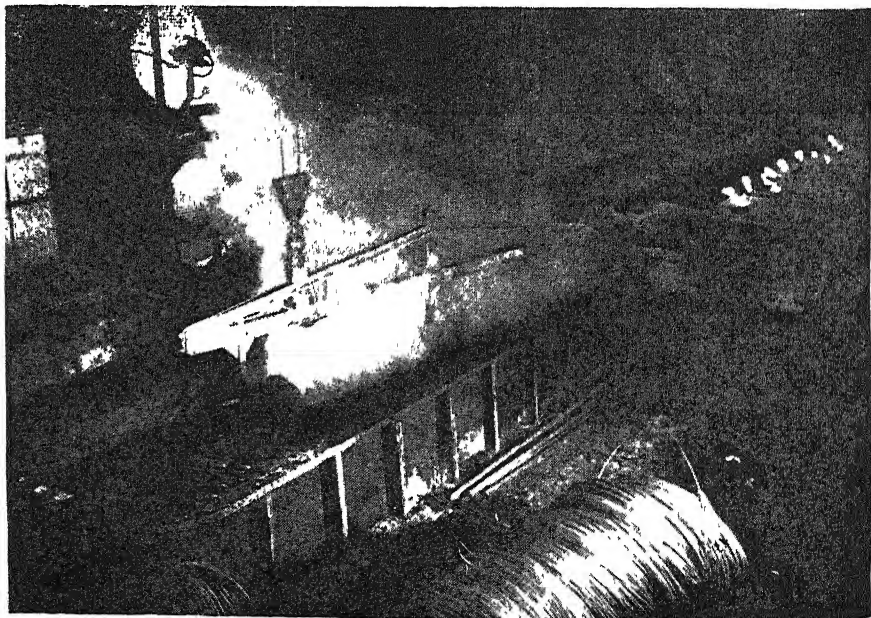
STEEL DESCALING

*Being Successfully Accomplished
With Sodium Hydride Bath*

STAINLESS STEELS, tool steels, and other alloy steels are being descaled by treating them in a fused caustic soda bath containing sodium hydride. This work is now being done at several stainless and alloy steel mills with considerable improvement in quality and material-economy.

In operation, sodium hydride is added to a bath of molten caustic soda and the scaled material held in the bath at, for example, 700 degrees, Fahrenheit, for a time ranging from a few seconds to half an hour. The metal is quenched from the high temperature into a water-tank, the mixture of surface salts and loosened scale being thrown off the surface to leave a uniform matte finish.

The process, developed and controlled by Du Pont, is notable for the large amount of time it saves in descaling or pickling alloy steels.



Quenching stainless steel wire after treatment in sodium hydride tank at right

Plastics

and

Fires

Although No Longer Novel and Unfamiliar, Plastics Materials Have Met Occasional Opposition on the Grounds that They are Too Flammable and Raise Gas Hazards in Fires. Tests Disprove Such Views and Show that Plastics are No More Dangerous than Most Other Substances

BECAUSE plastics now appear in our homes, our offices, our businesses, and are an accepted part of our daily living, it is pertinent to inquire whether they expose us to any new hazards, particularly those from fire. Careful investigation has been made of this latter possibility and searching tests reveal neither any new hazards inherent in plastics nor any old hazards that they have perceptibly increased or even affected. These points are important, because the utility and variety of plastics as well as the quantities available are mushrooming into a huge business.

The plastics industry has expanded headlong, and the trend continues at an only slightly slower pace. With a 100-million-dollar plant expansion now going on, next year's production of plastics is expected to reach five times that of 1939. Current output is about a billion pounds a year. It is easy to forget that this is an expansion and not something entirely new; that only a comparatively few plastics appear in almost infinite variations of form and utility to serve thousands of purposes; that people have been living with plastics and meeting them in their homes and factories for a quarter of a century and more. It is also easy to develop a fear of what seems unfamiliar, and in this fact rests the value of dispelling that unfamiliarity with a report that proves plastics to be no more hazardous in fires than ordinary materials plentiful in every home and building.

A list of present commercial plastics extends almost indefinitely, but in the sense of practical fire hazard, the different synthetic resins com-

posing them differ hardly more than the several varieties of wood such as oak, birch, pine, or balsa. The nature of any added fillers also may affect the flammability and the fire hazard of plastics products, but these, too, do not perceptibly increase the danger. Indeed, no synthetic-resin has been found more flammable or more dangerous in a fire than wood, even in severe tests.

NATURE OF COMBUSTION — The composition of the plastics necessarily determines the decomposition products formed from it during a fire, and hence the individual fire hazard. In a fire, the oxidation process of combustion usually occurs in three steps: destructive distillation; partial combustion; and complete combustion. The first two steps occur when access of air is severely limited, and the third step when an excess of air is present, as from a strong draft. These steps are practically important, since each produces different types of toxic gases.

Destructive distillation characterizes a smoldering fire with a relatively little air available to it. The heated material only partially decomposes. Gases, the kind depending on the chemical nature of the burning material, are given off, leaving a residue consisting largely of carbon, soot, and charcoal. Particles of the soot form characteristic dense smoke.

The second step, also characterized by dense smoke, consists of the union of carbon with oxygen to form

the highly poisonous carbon monoxide. Since this gas is odorless, it is extremely hazardous.

In the third phase, ample air supplied to the fire burns any flammable gases present—carbon monoxide and those formed by destructive distillation. Plentiful oxygen burns carbon monoxide completely to harmless carbon dioxide. Other gases may be formed, depending on the nature of the burning material. The gaseous products of complete combustion generally are far less dangerous than those of partial combustion. For example, such toxic nitrogen compounds as ammonia formed by incomplete combustion will burn to harmless nitrogen and water vapor if sufficient oxygen is available.

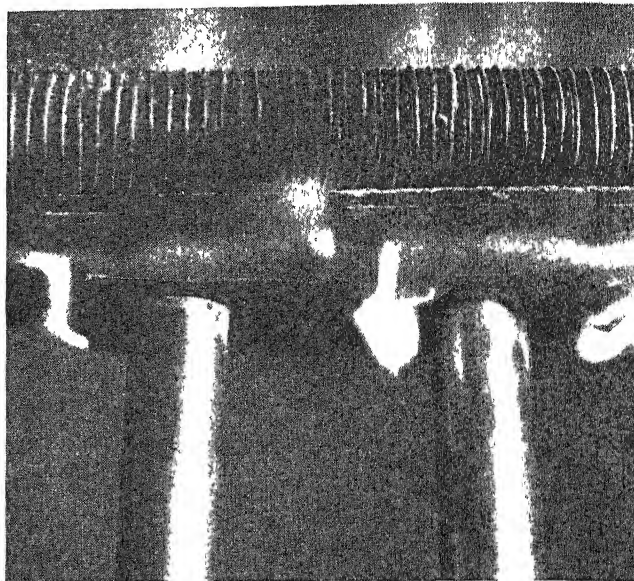
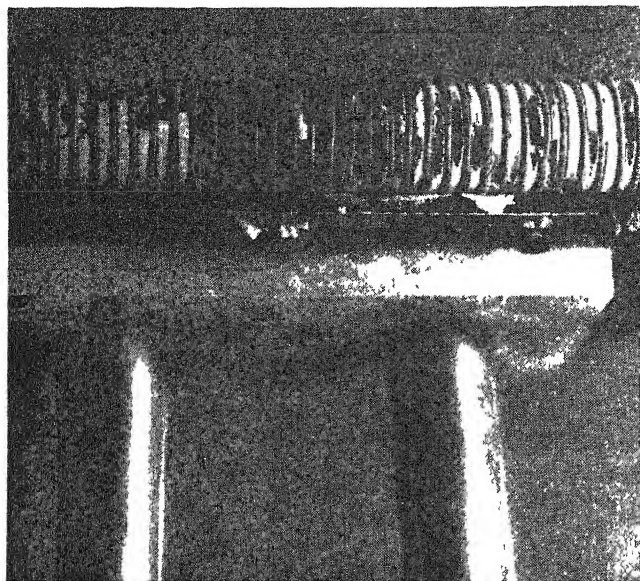
IGNITIBILITY AND FLAMMABILITY — Synthetic plastics generally are more difficult to ignite than wood. But whether a material will burn, and at what temperature, depends both on its chemical nature and on its physical form. Nitro groups, for instance, promote ignitibility, and Celluloid, which contains such compounds, burns very readily in thin sheets—more readily than paper or absorbent cotton.

Physical form may be even more important than composition. A fine powder is easier to ignite than a porous mass, and the latter in turn fires more easily than a compact solid. Kindling burns more readily than a log, even from the same tree. The same principles also apply to plastics.

Comparative tests indicate that synthetic-resin plastics generally are less flammable than wood. But hard rubber is much more easily ignited than any of a long list of synthetic plastics tested. Cellulose acetate is the most flammable plastics, except Celluloid, and the most easily ignited. Yet it is the base of safety film used in home motion-picture projectors and the Celanese of which dresses are made. Obviously a material which has been so widely and variously used is not seriously dangerous.

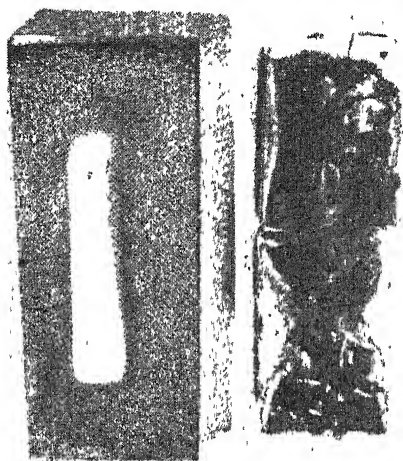
The relative ignition temperatures of some common materials have been determined in relation to plastics. Newsprint ignites at the lowest temperature (easiest to ignite), pine wood is next, then leather, then cellophane, and finally cellulose acetate which is more difficult to ignite than any of the common materials named.

Once ignited, cellulose acetate may burn vigorously, depending on the nature of the plasticizer present. Methyl methacrylate, Plexiglas,



Courtesy American Cyanamid Company

At temperatures of 500 to 1000 degrees Fahrenheit, a glass-filled melamine laminate and a similar block of cloth fabric-filled phenolic laminate (left and right above) show importance of selecting filler and plastics to fit job in hand. Two samples (right) are same blocks; glass-filled laminate is practically undamaged after one hour of heating, fabric-phenolic is badly charred after only ten minutes.



burns quietly at first and then more vigorously as it is decomposed by heat. Urea-formaldehyde and melamine resins burn with great difficulty, and the flame goes out when the material is removed from the source of heat.

FILLERS INVOLVED—Plastics commonly contain both resins and fillers. These latter may be flammable or non-flammable and their effects may be quite as important as those of the resins. A phenolic resin laminated with a paper base caught fire under test at the same temperature, 1100 degrees, Fahrenheit, as cellulose acetate. More difficult to ignite—that is, requiring a higher temperature—was a molded-phenolic plastics filled with wood flour; next was a molded-phenolic filled with asbestos; and another requiring an even higher temperature 1500 degrees, Fahrenheit, was filled with mica. This series demonstrates the effect of the filler in a family of poorly combustible plastics.

These tests emphasize the difference between organic and inorganic fillers. Paper, cotton, and wood, all organic, will burn by themselves. Asbestos and mica, inorganic minerals, will not burn. All synthetic resins, except the partly inorganic silicones, are entirely organic and burn if subjected to a sufficiently high temperature. A plastics com-

posed essentially of a resin and a filler will therefore burn more easily if the filler is combustible than if it is not.

Small sample slabs of several commercial plastics were held in direct contact with a luminous gas flame to test their behavior. Cellulose acetate, rated as a slow-burning material, melted while burning, flaming drops fell from the sample and continued to burn as they fell until completely consumed. Methyl methacrylate and polystyrene plastics behaved much the same. Flame progressed from bottom to top of six-inch samples of cotton-filled phenol-formaldehyde plastics after about five minutes' contact with the flame. The samples then continued to burn without flame. A wood-filled phenol-formaldehyde plastics, similar otherwise, failed to carry flame the entire length of the sample, but did show an afterglow. An asbestos-filled phenol-formaldehyde plastics, also similar otherwise, burned only during contact with the flame, the asbestos filler thus apparently suppressing flammability. A urea-formaldehyde plastics burned during

contact with the flame, but stopped burning shortly after the flame was removed. Most samples of vinyl plastics burned only during application of the flame.

HAZARDS FROM GASES — Very little experimental work has been reported on the actual combustion products of plastics. Nevertheless, the nature of these products can be deduced from their known chemical compositions. Apparently plastics first break down under heat into much simpler compounds, which may be the same as the original starting materials but usually are not.

In the preliminary stages of heating, phenol-formaldehyde plastics, the Bakelite family, presumably give off small amounts of phenol and formaldehydes, both toxic at certain concentration levels. Combustion of both phenol and formaldehyde in the second stage of the fire produces carbon monoxide.

Indeed, carbon monoxide is the greatest danger from poisonous gases at the average fire, whether in the home, office, theater, store, or warehouse. It is formed by the incomplete combustion of all organic materials—including all kinds of fabrics, whether clothing, rugs, or upholstery, of cotton, wool, linen, silk, or rayon; all kinds of wood; and all kinds of plastics. In an unventilated space, the concentrations of other toxic gases which may be formed are ordinarily insignificant in comparison with that of carbon monoxide.

Wood burning in a closed space gives 2 to 6 percent of carbon monoxide; simultaneously fractions of a percent of formaldehyde and of acetic acid are formed. Hence, wood burning without ventilation, and without a draft to carry off the gases

produced, is much more dangerous than phenolic plastics burning under the same conditions because the wood burns more readily.

Safety moving-picture, photographic, and X-ray films, commonly cellulose acetate, may produce as much as 25 percent of carbon monoxide, a concentration quickly fatal. Newspaper burned under the same conditions yields about the same amount of carbon monoxide and hence is just as dangerous as the acetate plastic. Or to put it the other way around, the acetate film is no more dangerous when burned in the absence of excess air than newspaper. Both acetate film and newspaper will give carbon dioxide and water when burned completely.

All plastics based on compounds which contain nitrogen, except Celuloid, produce hydrogen cyanide and ammonia on incomplete combustion. Such plastics include urea and melamine resins, and nylon. Usually phenol-formaldehyde plastics contain nitrogenous compounds which also decompose to ammonia and cyanide. The maximum safe concentration of hydrogen cyanide is 20 parts per million, but 100 parts per million of ammonia are safe.

NITROGEN COMPOUNDS -- The fire hazard of nitrogen compounds through the evolution of poisonous gases, particularly hydrogen cyanide, is not new but has long been known. Nitrogen-containing plastics are dangerous and they will produce hydrogen cyanide by destructive distillation. But so will other materials long familiar. Wool, silk, fur, leather, cheese, and milk powder, among others, all contain nitrogen compounds and will produce hydrogen cyanide on destructive distillation. Experiments with such materials lead reasonably to the conclusion that plastics containing nitrogen are no more dangerous in a fire than wool or leather.

During a fire, a closet full of woolen suits is a much greater potential danger as a possible producer of hydrogen cyanide than a whole set of Beetle or Melmac dishes. A small, closed den furnished with several pieces of leather-upholstered furniture and shelves of leather-bound books is also a potential source of hydrogen cyanide during a fire.

No one need, on this account, discard leather furniture or refuse to buy new leather articles. Neither need women discard silk and nylon hose for rayon, merely because silk and nylon yield hydrogen cyanide in a fire and rayon does not. The conditions under which silk and nylon yield hydrogen cyanide would

necessarily produce carbon monoxide and ammonia as well, and clearly a dangerous concentration of hydrogen cyanide would be unavoidably accompanied by dangerous concentrations of carbon monoxide and ammonia. Since all of these toxic gases burn completely with plenty of air and become harmless products, only during destructive distillation or incomplete combustion are poisonous gases evolved from these nitrogen-containing materials.

Wool also contains sulfur which may yield toxic hydrogen sulfide during the first and second stages of a fire and toxic sulfur dioxide during the third stage. Rubber, both natural and synthetic, also contains sulfur. But none of the common plastics do.

NO INCREASED HAZARDS—Some plastics—Vinylite, Koroseal, Saran, among them—contain chlorine which may form hydrochloric acid in a fire. Still others, the glyptals, are formed from glycerine and yield poisonous acrolein on partial combustion, just as do butter, lard, and cooking fats.

Destructive distillation or partial combustion of plastics thus, obviously, yields toxic gases; but these, with the single exception of hydrogen chloride, are identical with those formed under similar conditions from such familiar materials as wood, leather, silk, wool, and fats. All yield carbon monoxide as their major toxic product and this gas continues to constitute the predominant fume hazard of all fires. Other toxic gases probable in fires of either plastics or the older familiar materials are ordinarily small or even negligible as compared with carbon monoxide, which can be considered as quite unaffected whether plastics are present or not.

Clearly then, plastics introduce no new hazard into the fires of 1946 which did not exist in those of 1936, or of 1916, or even of 1896. Here, evidently, is a whole series of new developments that will make our lives easier and better without at the same time exposing us to any new hazard—even from fire.

• • •

PLASTICS OYSTER SHELLS

*Lighten Shipping Weight,
House Live Oysters for Days*

SUBSTANTIAL economy in shipping oysters is reported through the use of plastics cases for the succulent bivalves after they have been re-

moved from their heavy natural shells. The idea is to remove the oyster from the shell and immediately place it in a light-weight plastic duplicate of the shell.

Tests have shown that the oyster will continue to live for many days under refrigeration in artificial shells made of some of the newer types of highly resistant plastics, and these can be shipped at a small fraction of the weight of the natural shells. Thus it is planned to ship to remote points only good looking half shells and to leave all other shells as near the point of origin of the oysters as possible.

COLORED RUBBER

*Toughened by White
Substitute for Carbon Black*

POWDERY silica, suitable for incorporation into rubber stocks can be made by burning a colorless organic liquid, ethyl silicate, to produce silicon dioxide, or silica, in very fine particles similar to a smoke.

Under the electron microscope the particles are seen to be of the



Ethyl silicate burns to give a white deposit of fumed silica on the plate

same size and shape as superfine carbon black, which is also produced by a combustion process. The new material, however, is white and partly translucent.

Its physical similarity to carbon black makes possible its use as a substitute for carbon black in the compounding of rubber. Here, the silica performs in exactly the same way as carbon to give the rubber increased tear and abrasion resistance, and higher tensile strength. It will be possible to make strong rubber goods of any color with the new material since the silica will not interfere with the color.

Commercial utilization of fumed

silica will not be realized until mass production reduces the price. It is presently much more expensive than carbon black, officials of The B. F. Goodrich Company, developers of the new material, point out.

FREON FLAME-QUENCH

*Better Than Other
Gases as Fire Extinguisher*

A REFRIGERANT employed in some large air-cooling systems, Freon 11 can be used effectively to extinguish gasoline fires and prevent explosions. Other inert gases which have been tested and ranked in descending order of their effectiveness as flame-quenching agents are Freon 12, Freon 21, carbon dioxide, automobile-exhaust gas, and nitrogen.

Of the Freon series, dichloromono-fluoromethane or Freon 21 probably is the most commonly used in refrigerating and air-cooling systems. Freon 11, the best flame-quenching agent among those tested, now is used in centrifugal compressors, feasible only for large refrigerating or air-cooling units. The investigations have been carried out by the Bureau of Mines of the Department of the Interior.

COAL ACIDS

*Foreseen as Inexpensive
Ingredient for Plastics*

POWDERED bituminous coal, oxidized with gaseous oxygen in the presence of aqueous alkali, forms, in a new process, polybasic acids which go into solution in the alkali. Acidification followed by solvent extraction yields the acids in the amount of 60 percent of the weight of the coal charge.

The acids are a mixture of aromatic acids which behave chemically like phthalic acid in forming plastics. They are recovered as a light yellow to brown powder.

The process is now in the pilot-plant stage at Carnegie Institute of Technology. Since the raw materials are all cheap and abundant and the process applicable to large-scale manufacture, extensive use of these acids is foreseen in the production of plastics, plasticizers, and other organic compounds.

PLASTER AND PLASTICS

*Are Combined for
Greater Strength*

IMPREGNATING plaster of Paris with resins constitutes a new use for plastics and results in products applicable to the field of ceramics.

Two techniques are used for impregnating plaster with plastics: with one, solutions of the resin are made up and the plaster is added; with the other, resin in a dry state is mixed with the plaster of Paris and water is then added. The latter technique limits the selection of resins to the melamine and urea types. The result of the process is an improved product which has acquired the durability of the plastics without sacrificing plaster's low price advantage.

Most earlier efforts to pre-combine plastic with plaster of Paris encountered some loss in ease of handling the plaster—either because of greater problems in mixing, accompanied by lumping and formation of gas pockets in the final castings, or because of delay in setting of the plaster and in the development of good early strength.

Another process, the impregnation of finished plaster castings with various resins uses a low viscosity furfural resin, developed exclusively for the purpose. Furfural resins possess excellent wetting properties, and will readily penetrate into plaster. Application is either by immersion or brushing on the final shape. Water soluble phenolic resins can also be employed, and after the water has been removed may be effectively cured to develop good strength properties. The combination, however, lacks both the strength of the furfural resin impregnated types and the ability to take high operating temperature for appreciable periods.

Furfural resins contain no solvents, and although they may be cured ultimately at room temperature, heat curing is recommended. When full impregnation is practiced, the resin impregnated plaster is heated slowly not only to avoid stresses, but also to prevent sweating out of the resin on the outside surface.

When maximum impact strength is desired, cotton or glass wool is added to the plaster of Paris before pouring. Subsequent curing with furfural resin will then give a structure capable of taking much mechanical abuse. Application of furfural resins to dry plaster of Paris forms does not result in any build-up on the surface of resin. The processes described were reported to the Society of Plastics Industry, by J. Delmonte.

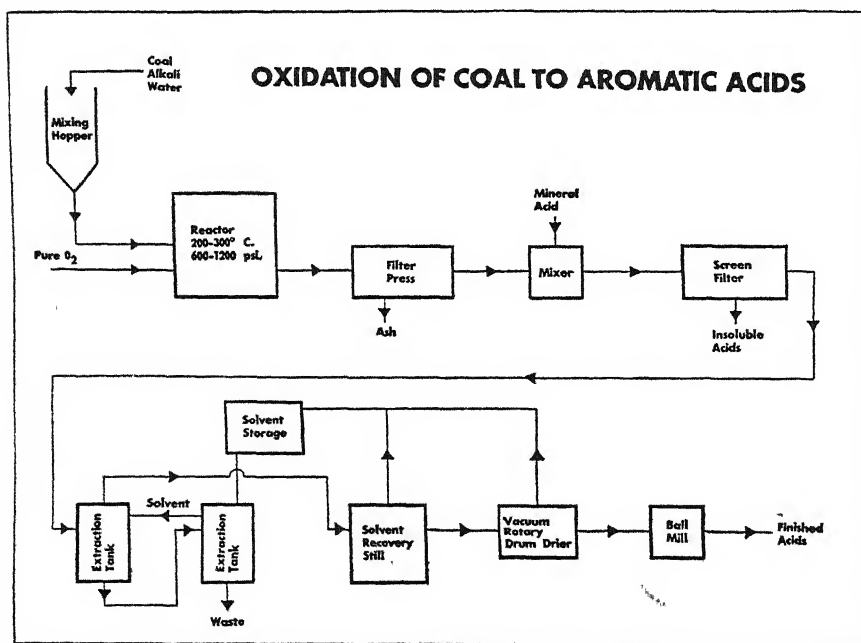
AIR DISINFECTION

*Accomplished by Vapor
from Lacquer Solvent*

TRIETHYLENE glycol, a chemical largely used as a solvent for nitro-cellulose lacquer and as an intermediate in the manufacture of plasticizers, is now recognized as an effective bactericide. In tests, one gram of it vaporized in 200,000,000 cubic centimeters of air rapidly killed the organisms responsible for pneumonia, influenza, streptococcus infection, catarrh, colitis, and other diseases. Preliminary results show that it may even control tuberculosis and the common cold.

At the concentration used, the material is not harmful to persons or animals, fabrics, or painted surfaces. The glycol is effective only at fairly high humidities, which leads to the theory that the moist surface of the organism attracts the hygroscopic chemical, which coats the germ with a lethal layer.

Units suitable for vaporizing the glycol in houses, schools, hospital wards, and so on, are manufactured by the Rogers Diesel and Aircraft Corporation.



Simplified flow-chart of the production of acids for plastics

Moisture Meters Move Up

By EDWIN LAIRD CADY

AN EXPORTER got several car loads of dehydrated pea soup as far as the Atlantic seaboard. Then he put in a frantic call for a moisture meter. An inspector had opened a package of the food, found that it contained more than the permitted amount of moisture, ordered further drying before export shipment.

The drying was done, the packages re-sealed, and the food sent on to Europe. A moisture meter, a handy device which costs less than \$250 and is as easy to use as a foot rule, first had shown how much drying needed to be done, then had proved that it had been done.

A painting contractor made an agreement to paint the plaster walls of an office building and have the job done in five days so the new tenants could move in. He too was in the market for a moisture meter. Knowing that if his work failed to stand up after the paint had been on for a year or more he never would get another contract from that realty company, he had stipulated that he was to be permitted to delay his contract if the plaster was too damp for good painting.

The building superintendent said that the plaster was dry enough, the painter said it was not. To settle the point, they bought a moisture meter of a model costing less than a set of good paint brushes. They went over all of the walls with this, found some surfaces which had less than the 5.5 percent of moisture which is the top limit for good painting of plaster, found other areas with more moisture than that. Then they worked out a schedule by which the dry areas would be painted first and the wet ones be given more time to dry out.

From that day on, the realty company specified the use of a moisture meter in every painting or other wall finishing contract. The meters also find damp spots which show that pipes are leaking, roofs are defective, or outside walls are seeping. They show just where walls ought to be better insulated to cut down condensation or "sweating." Moisture meters find dampness

Portable, Quick-Indicating, and Inexpensive Instruments—that Show How Wet, or Dry, a Material Really is—Take Guesswork Out of Jobs Ranging from Painting Walls Through Multi-Color Printing

• LOOKING AHEAD •

Extensive use of moisture meters in food production—from farm, to packer, to retailer. . . Better printing jobs and fewer "off-register" color runs. . . Safer storage of coal, grains, and other combustibles. . . More accurate lumber seasoning and closer matching of lumber to end-use climates.

troubles while they still are small, permit large maintenance bills to be headed off.

FURNITURE SUITS CLIMATE—One of the furniture companies studied such experiences by several realty companies, came up with a new philosophy which may change segments of the whole furniture industry.

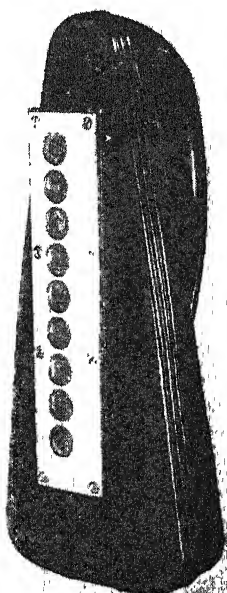
The new idea is to go to large real estate companies all over the

country, study the records of the moisture conditions that their meters have found inside buildings, then build furniture of woods having moisture contents controlled to fit "room climates."

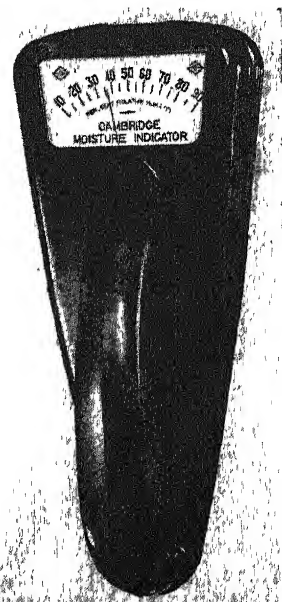
Everyone has had the experience of having the drawers of a new piece of furniture stick and jam or else get so loose that they are hard to handle, while an old bureau behaves perfectly. And nearly everyone has shipped old furniture from one section of the country to another, only to have it start misbehaving like brand new.

The reason is that wood will take on moisture from a room which is damper than itself, give off moisture to a dryer room. The dampened wood swells and warps, the dried wood shrinks. Let a piece of furniture grow old in one climate and it becomes balanced to conditions; in more technical language, it becomes "stabilized to average conditions."

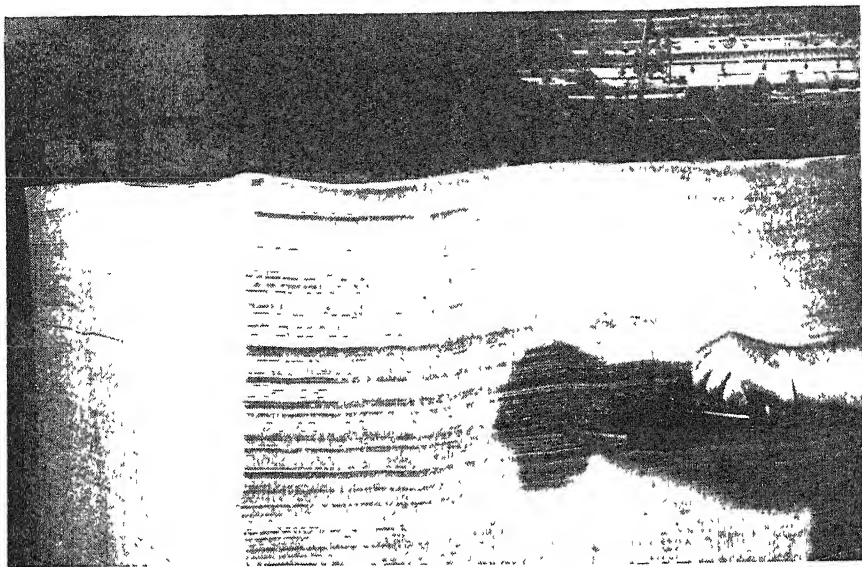
Furniture made according to this



Contact side (left) and meter side (right) of a surface-type moisture meter. Variety of applications necessitates many different instrument designs



Courtesy Cambridge Instrument Company, Inc.



latest notion will be pre-stabilized. By using plenty of moisture meters in the lumber kilns and in the furniture factory the moisture content of each piece of wood will be closely controlled. Furniture intended for the damp climate of New York will have a higher moisture percentage, pieces to be shipped to arid Arizona will have much less moisture, every region will have its specific moisture gradient. The result will be that, no matter where it is bought, brand new furniture will behave as well as if it had stood in one room for years.

MOISTURE-METER FARMING —

Farmers have picked up the moisture-meter idea. Instead of depending upon the vagaries of sun and wind to dry their alfalfa, hay, grain, and other feed crops, they are installing recirculated-warm-air drying sheds which are as closely controlled as many an industrial installation. The sun can bleach out some of the food values; the race to get the crop in before an unexpected rain storm arrives can lead to the storing of materials which are so damp that later they will mildew or rot. But with handy moisture meters telling just how much moisture needs to be removed and recording the process of mechanical drying until the moisture balance is proved to be ideal, the highest food values can be obtained and spoilage reduced.

Based on such use of moisture meters on the larger and better farms and ranches, a whole new industry of building crop drying and conditioning equipment is growing up. This industry is so new that relatively few, even among the farmers, have heard of it. But let present business conditions reverse themselves so there is an over-supply of plywood, sheet steel, and other

Checking moisture content of stacked paper (above) before printing helps ensure accurate register of color. Bayonet extension (right) is used for such tests and for grain, cotton, and other products to take "middle-of-material" measurements.



suitable wall materials for drying rooms and there will be a rush to develop this market which the portable moisture meters have made possible.

PAPER FIRST—The paper industry was one of the first to take hold of highly accurate, portable moisture meters. Paper is very susceptible to moisture content and conditions. Get too much moisture into it and it will wrinkle. With too little it is weak. Such standard tests as tensile, bending, bursting, and folding strength, are meaningless unless the tester knows the moisture content of the paper. And that content will change with every prolonged variation in the relative humidity of the surrounding air.

Paper makers used to use oven-drying tests—weighing a sample of the paper, baking the moisture out, and then weighing the dry sample to see how much moisture was lost—for all of their control operations. They still use the ovens for highly sensitive laboratory tests. But an

oven test can take hours where a portable moisture meter needs only seconds. By the time the oven test was finished the moisture conditions often had changed. The moisture meter tells what is going on right now.

Fabricators of paper, such as makers of milk cartons—"paper milk bottles"—and of other paper boxes, check moisture content continually. And they avoid many losses and wastes which used to occur when they had to judge moisture content by guess and by feel.

The paper is specified to have certain moisture content as shipped from the mill. But this can change if the paper encounters extremely humid or dry conditions en route to the fabricating plant. In any case, such specifications must be within limits of percentages and it is wise to know exactly what the moisture content is as the paper starts down the production line. Exact control must start with exact knowledge.

As the paper proceeds from one process to another, through rolling, slitting, printing, creasing, waxing, and assembling machines, it is checked by moisture meters and moisture may be added or removed at every step. Too much moisture means trouble when printing and waxing. Too little, and the paper will shear instead of creasing, especially in modern high-speed creasing machines.

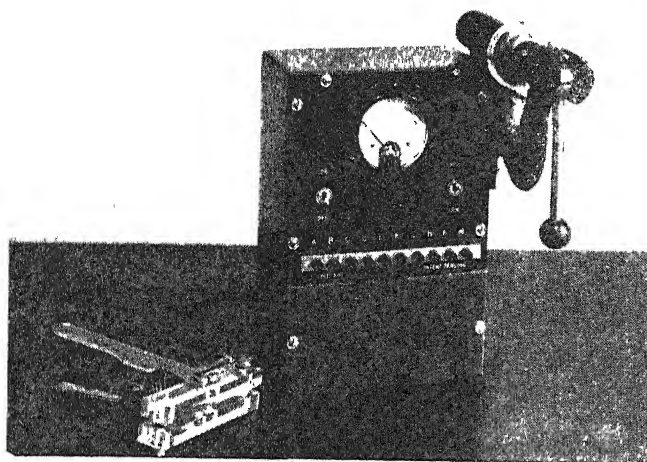
Ordinary printing shops are using moisture meters, and will use a great many more of them when adequate supplies of parts permit more meters to be made.

The important point in the print shop is to have the paper at a moisture content which corresponds to the relative humidity of the room. Paper changes in dimensions slightly as it takes on or emits moisture. It also changes in its readiness to take ink and to permit the ink to dry.

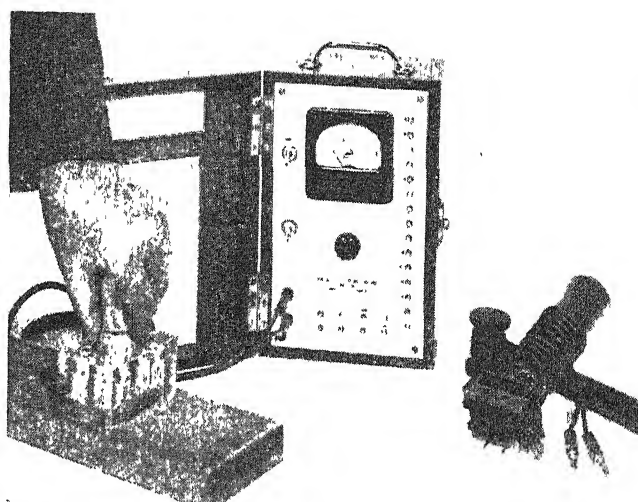
When only one color is to be printed, the problem is merely that of taking ink and of drying without offset, excepting in those rare cases where the relative humidity within the shop changes so drastically that the paper will curl or become wavy. But when two or more colors are to be printed, and the second color-run must be in register, then the changing dimensions can be damaging.

The top sheets of a pile of paper will change quite readily. Paper takes on or gives off moisture very rapidly and the sheets exposed to the air soon are in equilibrium with the relative humidity of the air.

What the printer needs to know is the condition within the pile and



Meter with clamp-type contacts (left) is used for determining moisture in single sheets of paper as, for example, when paper is passing through dryer in mill. Another instrument (right)



is shown with a "press-down" contact for testing wood—springs in contact provide even pressure. Spike contact seen at right is tapped into wood with hammer to get under-surface readings.

whether or not he is going to find the first sheets printing one way and the succeeding ones another. For this he uses a portable moisture meter with a bayonet-like blade which can be thrust between the mid-sheets without damaging them. This meter first tells him the relative humidity of the room, then that of the middle of the paper stack. From a comparison of the two he knows whether to go on and print or hang the paper or otherwise bring it into equilibrium with the relative humidity of the room.

FIRE HAZARDS—Moisture in coal and in some other materials can be a source of chemical changes which generate enough heat to cause spontaneous combustion. In other materials the absence of moisture can be a fire hazard.

Here the moisture meters must be highly sensitive. Often they op-

erate within one tenth or less of the range which would be practical for lumber or paper.

The makers of moisture meters have highly practical sales set-ups for meeting such conditions. Their usual procedure is to ask the prospective industrial customer to send in samples of exactly what he wants to check, and tell how and under what conditions he wants to check it.

The samples are dried carefully under laboratory conditions, and instruments are calibrated especially to measure their rates of drying.

A study also is made of the physical application of the meter. It may need pressing down of a contact upon the material, or squeezing of thin materials between the faces of a clamp, or holding of a powder in a cup, or driving of tiny spikes to get below a tough surface and find the interior conditions, or running of a

roller along a material which is to be in motion.

Many of the resulting applications are highly secret. Others, like the use of meters for purchasing raw materials, are so wide open that the type of meter to be used and the method of using it are specified in purchase contracts.

Purchasing agents who are moisture-meter wise refuse to pay goods prices for excess moisture. They will bore a hole into the middle of a bale of cotton and extract a core, plunge an instrument into a bale of hair felt, check up almost any moisture-bearing material which is bought by weight.

Only a few years ago moisture meters were curiosities. In a short time they will be as common as micrometers. There is no industry which cannot benefit in many ways by the closer and more facile measurement of moisture.

HANDY HYDRAULICS

Come as Light, Portable

Units to Multiply Manual Power

ONE MAN can apply tons of power just by using his own muscles, if he applies it slowly enough. This fact, known to the ancients who used hydraulics to move the arms and legs of stone statues in their temples, is also being applied to thousands of brand new services right now.

The new applications come from recently designed, portable, hand-operated hydraulic rams. Such rams never could have been made without the modern metals and fabricating processes which can produce great strength with light weight and low bulk. But with a ram of modern type one man can lift a huge crane off from its bed for repairs,

move a freight car, separate enormous dies without hammering, straighten a shaft without removing it from its bearings, and perform thousands of other tasks which require force without shock or speed.

ACTUAL LIMITS: SHOP LIMITS

Differ as Machine Tools

Give Closer Performance

THE OLD-TIME way of handling dimensional limits along production lines was to let the machines work clear up to the limits with the expectation that no more than 10 percent of all output would be beyond the limits and therefore rejected.

Behind that philosophy was the fact that old-time machines were hard put to it to hold any close limits while working at high speeds.

Limits wise, the product designers were way ahead of the abilities of the machines and the only way in which the machines could be run at a profit was to give them all the tolerances they could have.

Today the situation is reversed. Dozens of different kinds of machines can work at higher limits than the designers need and still produce at top speeds.

The tendency, then, is to set limits closer than the actual ones and to warn foremen when the actual ones are approached. If actual limits are plus .001 or minus .001 inches, the shop limits will be set at plus .0008 or minus .0005 inches, for example, and the foreman warned when these limits are exceeded. The result is production with seldom or never a rejection.

OF ALL phases of modern aviation private flying probably has advanced least rapidly. Some authorities contend that this is because airplane constructors and designers have been reluctant to take up such new ideas as, for example, the tricycle landing gear, simplified "two control" systems, and a number of other design features of more recent origin. The plane constructors, on the other hand, say that they are constantly improving their designs and that progress should be a matter of evolution and not revolution.

ROADABLE PLANES — A typical case in point is the "roadable airplane." One objection which people frequently make to private flying is that a car is needed to get to the airport, and another car is needed at the other end to reach the destination. The objection is well grounded and the natural query is, why not build an airplane which will be as useful on the road as in the air, just as the amphibian can make use of a landing field or water base.

Theodore P. Hall, Chief Research Engineer of Consolidated Aircraft, not only designed such a combination aircraft but the hybrid has been built and successfully flown by Willis Brown, of Southern Aircraft. Whereas some roadable planes have been designed so that the wings were carried along with the plane when it was converted into an automobile, the Hall-Brown craft follows another favorite plan of detaching the wing, tail, and propeller units at the airport when the flight is over. This leaves a practically conventional automobile at the pilot's disposal.

Although Many Authorities State that Private Aviation is Progressing Nicely, Others Submit that the Pace is Plodding. The Latter Maintain the Path is Blocked by Designer-Manufacturer Reluctance to Move Out with New and Sometimes Revolutionary Plane Designs and Accessories

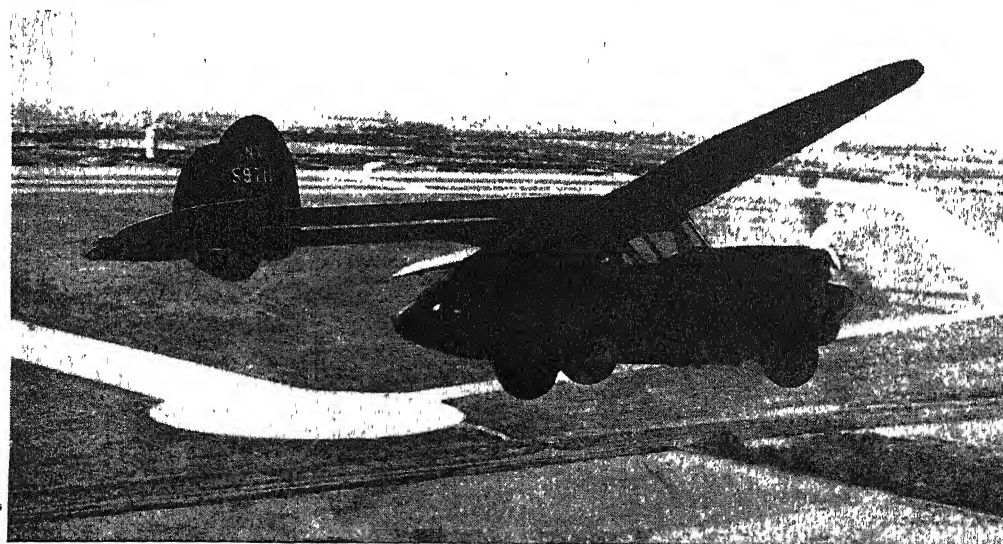
The "Roadable" has a gross weight of approximately 1800 pounds; with a 130-horsepower, 6-cylinder air-cooled engine it has a top air speed of 128 miles per hour and a cruising speed of 110 miles per hour. The wing span is only 30 feet. In the air the craft does not differ very much in appearance from a conventional airplane, except that the usual fuselage is replaced by a short, automobile-like body, and the tail surfaces are carried on two booms mounted on top of the wing. The wheels, three in number, are left partially exposed in flight, the engine is located at the nose of the body, and there is a propeller of the usual type. Rudder pedals are employed, and a steering wheel which controls the ailerons and elevator in the air becomes an automobile steering wheel on the ground. When the wings, tail surfaces, and propeller are removed, the effect is that of a neat coupe, with all the conventional automobile controls including a clutch, brake, foot throttle, and so on.

Although the objectives of this design are thoroughly worth while and the tests have been entirely satisfactory, it is possible to advance a few arguments against the project. The combination will be more expensive than an ordinary Cub; and performance will not be quite as

good as that of an airplane of similar power and passenger capacity because the automobile part of the craft necessitates more weight and more aerodynamic drag. Also, there is considerable additional mechanism. For example, there are two clutches—one for the propeller and another for the rear-wheel drive.

Any combination of functions, as in the "Roadable," usually means complexity. The plane, as such, will not be as good as it might be, nor will the car be as good as others on the road. Furthermore, it will be very easy to take the airplane wings and tail surfaces off, but there remains a question of whether there will always be good enough mechanics at the airport to guarantee safe flight afterwards. These, of course, are valid objections. But similar objections were made when the amphibian was first suggested, and the amphibian is commonplace today.

JET PROPELLERS—Another radical departure, a small plane to be powered by a jet-driven propeller, emanates from the Cleveland Aircraft Engine Laboratory of the NACA. The plane would be a tailless machine, with the propeller at the rear. Airscoops in the leading edge of the wings would lead air in-



Roadable plane, still experimental, matches popular concept of what such a craft should be on most points—price excepted. Wing-tail unit and propeller are taken off at airport; a mechanic must reassemble them to body before next air trip

The Air

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate,
Daniel Guggenheim School of Aeronautics, New York University

to the propeller hub. Here, the air would be compressed by centrifugal action during its passage through hollow propeller blades towards the tips. Fuel would be injected into small combustion chambers near the tips and the mixture would be ignited electrically. Hence, rapidly expanding hot gases would push out through nozzles at the tips and the nozzles, tangential to the blades, would impart a revolving motion. As conceived, it would be an extremely simple powerplant without the conventional carburetor, open-

ing or closing of valves, magnetos, or timing problems—without anything, in fact, but the propeller, the ignitor, a few passages, and the combustion chambers. Admittedly, the efficiency would be low, and more fuel would have to be burned for a given power than in the usual engine. But nearly any fuel—kerosine, for example—would do, and the lightness of the power plant would be a genuine compensation.

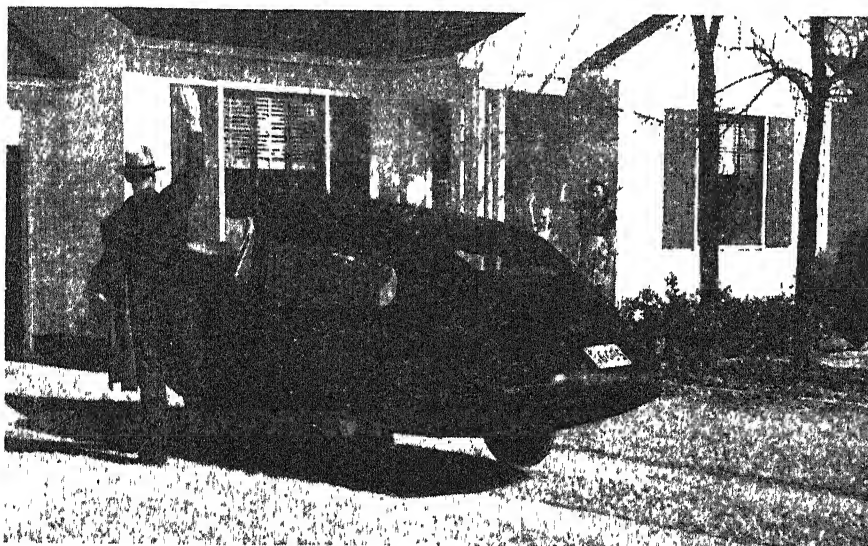
In connection with such a device it should be remembered that jet reaction is only efficient when the

• LOOKING AHEAD •

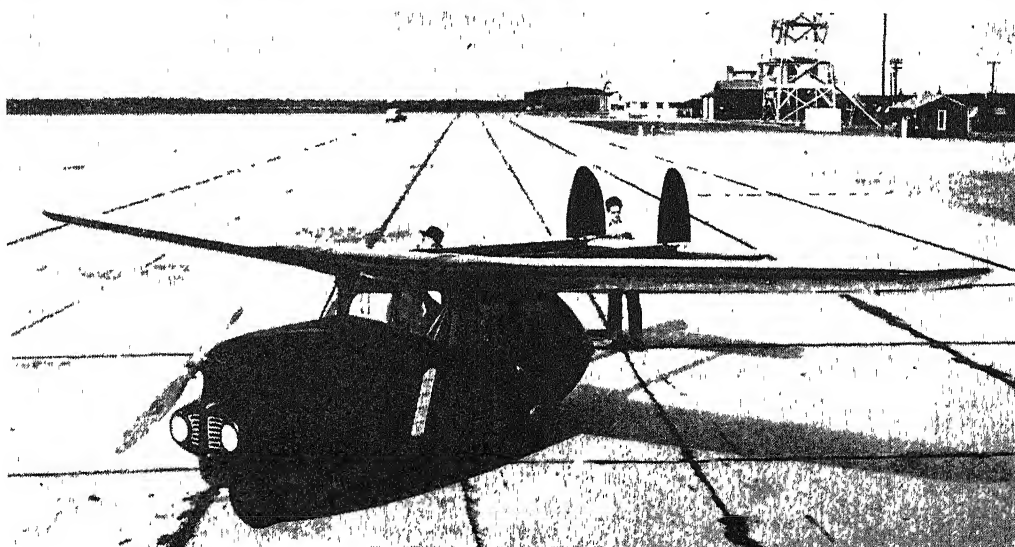
Practical, workable, airplane-auto combinations. . . Jet-power applied directly at the propeller tips. . . Eventually, a completely "natural" single control. . . Take-off and landing aids for short-run, down-town airports. . . An aircraft-accessories market rivaling the automotive field.

moving body has a high velocity, close to the velocity of the issuing gas. Therefore, it would be necessary to realize something close to equality between the speed of the products of combustion and the speed of the propeller tips. Other questions surrounding the idea are: will compression by centrifugal force be sufficient or must some other means be employed for increasing compression; will the hot exhaust gases rushing out at high speeds be dangerous; and will the nozzles have a satisfactory service life?

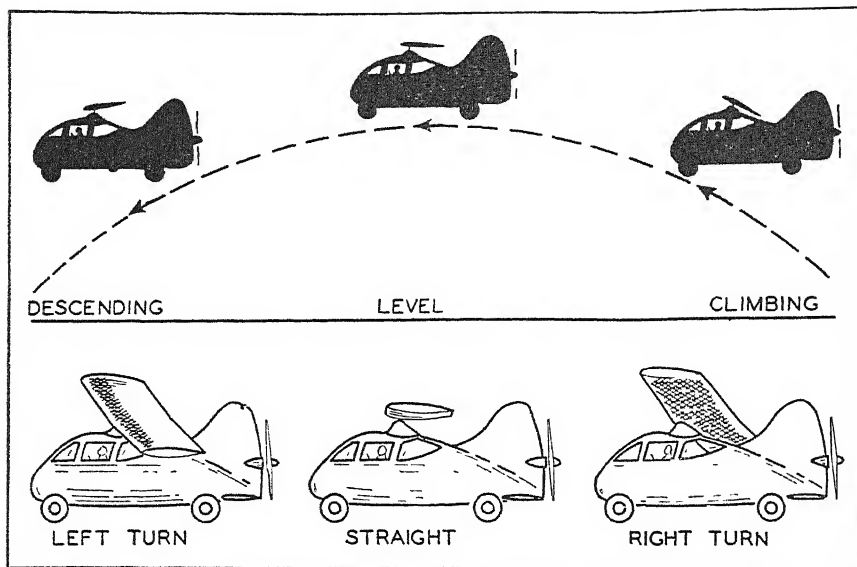
ROOM FOR IMPROVEMENT—One major problem in light-plane flying is getting in and out of small fields. Grover Loening, Special Consultant to the NACA discussed this problem at a recent meeting of the Institute of Aeronautical Sciences. Mr. Loening did not advocate a radical change in plane design, but rather the use of landing and take-off aids. It was suggested that a small cable operated by an electrically-driven catapult drum would get the ordinary light plane off in an amazingly short distance. For landing, the use of a simple arresting device—



Home scene (above) depicts busy man leaving for airport where hybrid craft will be converted to a plane (right) for a fast business trip. From technical viewpoint, neither car nor plane is as efficient as non-convertible types



Photographs courtesy
Southern Aircraft Company



Spratt wing, a current "single-control" experiment, pivots entire airfoil on universal joint. Idea appears good; mechanical execution may prove difficult

four or five cables that would catch a hook on a plane just as in a carrier-deck landing device—was proposed. Simplicity would point to the incorporation of landing and take-off features in the plane itself, but simple devices of this character may hold some promise.

From the standpoint of unconventional control systems, there is the Spratt wing which may work out for light-plane application. The early aviation pioneers who used gliders for their studies—Lilienthal, Pilcher, and Chanute—secured control by shifting their center of gravity relative to the wing. Now there has been designed, built, and flown a small airplane in which control is obtained by shifting the wing relative to the center of gravity. In this craft the wing is mounted above the fuselage and is allowed freedom both about a transverse axis and about a backwardly inclined axis.

Tilting the wing backwards effects longitudinal control and causes the plane to climb, while tilting the wing forward brings about descent. Lateral or turning control is obtained by tilting the wing down on the right or left. Thus, it is possible to have but one control with the one stick guiding the plane up or down or sideways while the fuselage always retains the same level condition for greater passenger comfort.

Mechanically, this design is not quite so simple as it sounds. Mounting the wing above the fuselage and giving it universal freedom poses structural problems, and the positioning of the axis involves considerable study, tunnel testing, and careful free flight tests. Nevertheless, the Spratt wing does have the possibility of providing the simplest single control.

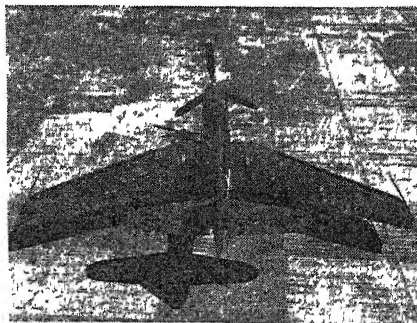
In addition to unconventional methods of designing the light plane itself, there is other research in the light-plane field which merits attention. In fact, the Civil Aeronautics Administration, the Aircraft Owners and Pilots Association, and the Aircraft Industries Association have submitted a whole series of pertinent problems to the NACA. Some of these should be attacked by in-

ARROW-LIKE WINGS

Represent New Approach to Compressibility Problems

JET PROPULSION, thin, blade-like airfoils; and other developments have carried airplane speeds well beyond 500 miles per hour — once thought to be the top limit because of air compressibility effects. Another approach to this problem is now being tried in the form of swept-back, arrow-shaped wings. Here, it is reported, if the "arrow" is sharper than the compressibility shock wave, many of the shock effects disappear.

Wind-tunnel tests of the design have proved satisfactory enough to prompt flight tests of a wing swept back 35 degrees on a modified Bell P-63. The experimental work has



Swept-back wings may solve problems

ventors, and others by designers and manufacturers. Oil companies, for example, have a standing challenge to produce safer fuels of a type which would decrease or eliminate fire hazards, yet have all the efficiency of the best gasoline. Manufacturers of electric-lighting equipment are being asked to provide light, high-powered landing lights. An inexpensive, light-weight radar collision-warning indicator would be a great boon when small-plane flying really gets under way.

Other problems which invite solution include: Fan cooling of enclosed engines; windshields with smooth water clearance, doing away with the need for wipers, non-icing fuel systems, still lighter small-plane engines, perhaps of the two-stroke type; small gas turbines for private planes; and more comfortable seating arrangements in the cabin.

It is apparent that the widest scope exists for the application of all manner of industrial talents both within and without the realm of the airplane proper. Were all such opportunities for aircraft and accessory research grasped, it would most certainly make a great difference in the further progress of the light plane.

been carried on jointly by Bell Aircraft and the United States Navy Bureau of Aeronautics

AIRCRAFT STATIC

Stems from Broken Snow Crystals and Friction

SNOW produces radio static in an airplane because snow flakes do not follow the airflow pattern of a plane in flight, but instead hit the plane and at high speed break into a number of fragments. On breaking up, the flakes produce the static electricity which drowns out all other radio signals, according to Vincent J. Schaefer of General Electric Research Laboratory. Some of the electricity is carried by the snow from the atmosphere and some is created by friction. When the snow hits the leading edge of the wings or passes through the propeller at speeds of 200 to 500 miles per hour, fine ice dust is produced with attendant frictional electricity. It is this static electricity and its radio interference that is the greatest hazard in flying through a snow storm.

The actual impact of the snow is not dangerous nor does it accumulate on wings or other surfaces after the manner of ice.

Electrons Guide the Loom

Although an Ancient Art, Textile Making is Finding in Electronics a Wealth of New and Better Methods to Produce Flawless Fabrics and Keep Complex Mill Machinery Running Smoothly Without Breakdown

By VIN ZELUFF
Associate Editor, *Electronics*

• LOOKING AHEAD •

Extensive application of induction heating to heavy-fabrics manufacture. . . Reduction in second-grade cloth losses as electronic "stop-motions" are applied more generally. . . Greater thread uniformity as a result of increasingly accurate testing technology.

OF THE large number of new and improved types of electronic equipment which have been introduced to the textile industry, some have found wide use; others are still so new that only a few installations have been made. Equally important, many of these applications give promise of being suitable for modification and use by other industries, and in this group are the electronic yarn tester, "stop-motion" set-ups, stroboscopic observation techniques, and the use of high-frequency heating for steaming, drying, and so on

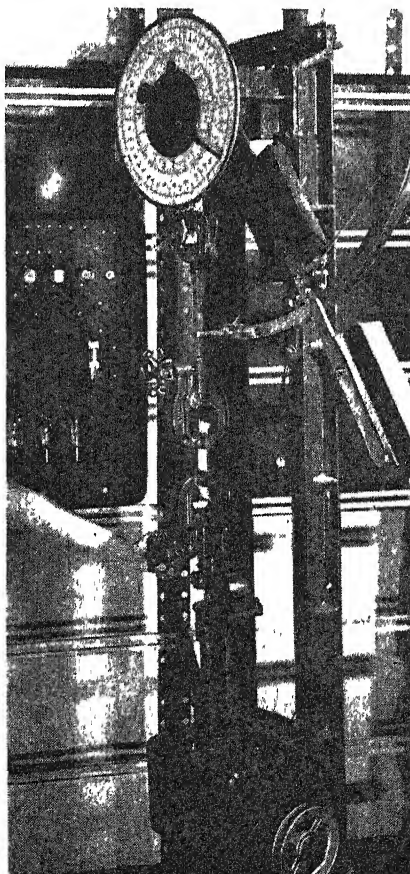
TO BREAK A THREAD—To assure uniformity in the manufacture of yarn, constant checks on humidity, temperature, material quality, and similar variables are necessary. But even with all of these factors established and controlled, it is still vital to make periodic samplings and tests of the finished yarn.

Early yarn-testing methods ranged from suspending a weight by a yarn sample held in the hand to various calibrated arrangements of balances, springs, pendulums, and like mechanisms. Of these, the pendulum appears to have retained its popularity and, with modern features, is still used.

Basically, the pendulum yarn tester combines the pull of two jaws

to hold and break the yarn which is stretched vertically between them. In operation, the jaws move apart, one is driven by an electric motor and the other by the action of the pendulum in moving a ratchet. When the thread under test finally breaks or pulls apart, a pointer shows the degree of strain or load exerted by the jaw attached to the pendulum.

One of the disadvantages of this type of machine is that the pendulum arm which increases the loading "bumps" its way in steps through the loading cycle and does not pro-



Electronic control (on wall) insures steady loading of yarn tensile tester

vide a constant rate of loading. Also, fabrics of different stretch characteristics cause the pendulum to move at correspondingly differing average rates.

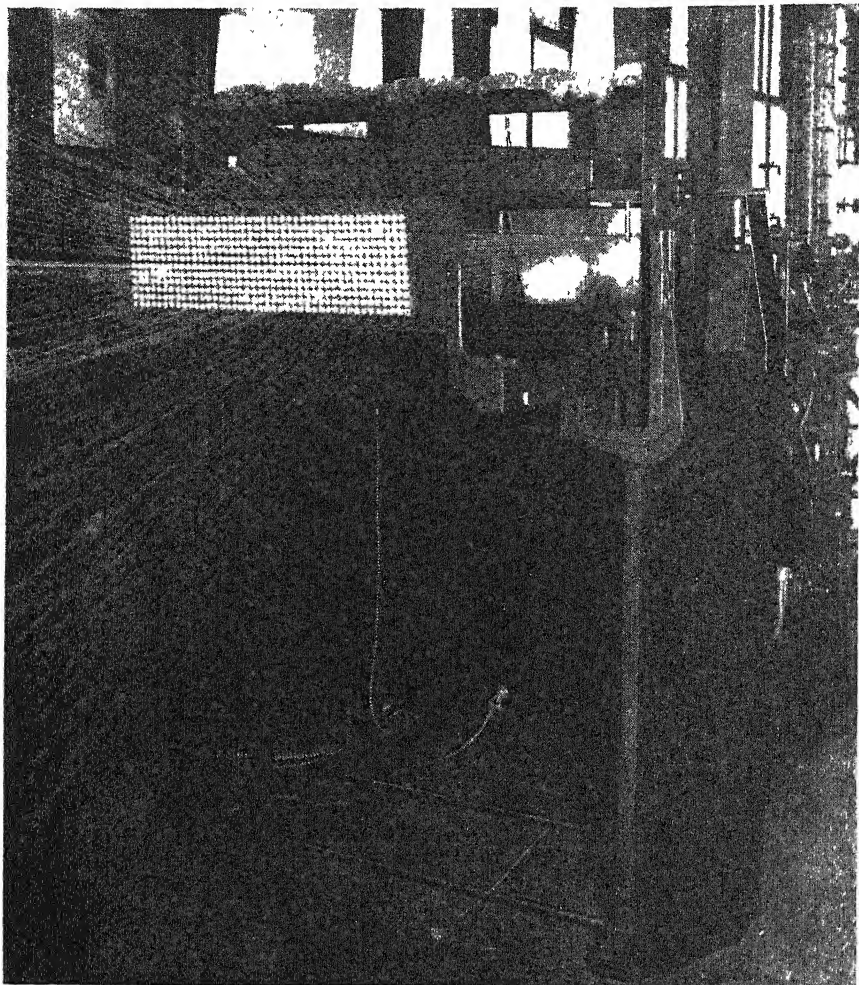
To extend the working range of the instrument, an electronic control has been successfully devised as an attachment to the standard pendulum-type tester to permit constant-rate-of-load tests to be run. Here, the movement of the pendulum through its arc causes an increasing electrical voltage to be applied to an electronic rectifier tube. The resultant direct current is then applied to a capacitor and an electronic control circuit.

Should the test specimen be capable of considerable stretching, movement of the lower jaw will be largely absorbed in the stretching, and the pendulum will tend to move at a rate slower than required. But when this lag develops, current passed by the capacitor decreases, as does the current and the voltage impressed on the grid of the speed-control tube. Thus the motor is immediately called upon to increase speed. As a result, the lower jaw is driven downward at a more rapid pace and the rate of travel of the pendulum is caused to increase to that required to maintain a constant rate of loading.

Conversely, if the specimen has a low-stretch characteristic, the pendulum attempts to move along too rapidly, and the control operates to decrease motor speed. The system is capable of handling fabrics possessing a wide range of stretch characteristics.

KEEPING FLAWS OUT — Although breaking a thread is a useful means of testing it, a broken thread in a textile machine used for spinning, weaving, or knitting is a serious occurrence that drastically lowers the market price of the material. For efficient loom operation, such accidental thread breaks must be detected and the machines stopped immediately; "stop-motion" mechanisms are used for this purpose.

Most stop-motions are electrical, with their action depending on the making of a positive electric contact at the instant a thread breaks. Should there be a delay in this contact, or otherwise faulty action, the broken end will pass on into the



Courtesy Van Raalte Silk Mills

Broken threads here could mean flaws in finished cloth. Electronic amplifier boosts signal from low-voltage contacts to actuate "stop-motion" mechanisms

finished goods and result in an imperfection.

The mechanism used to detect thread breaks must be small and light, easily set and adjusted, and must not interfere in any way with the normal thread motions. At the same time, it must be safe from both the operator and fire hazard viewpoints. These stipulations dictate the use of a low-voltage, low-power control circuit.

Air in textile mills, however, is laden with lint and dust and is also highly humid. Under these conditions, the contacts on the usual gravity-operated stop-motion drops may become fouled and operate improperly. Hence a device that will make contact infallibly in spite of these conditions, and at the same time introduce no new hazards, is required for complete stop-motion protection. An electronic relay does exactly this on textile beamer machines. Just before the threads come to the beamer, each thread passes through a hinged eyelet, called a drop switch. When the threads are wound on the beamer they are in tension and hold the drop switches in an open position. When a thread

breaks it is no longer in tension and the drop switch, its weight unsupported, drops to the metal bar.

The contact with the metal bar causes a minute current flow in the input circuit of the relay tube. This current, only a few microamperes, is amplified by the tube which in turn operates a relay in the output circuit. The relay then opens the coil circuit of the motor switch and stops the beamer machine. Entirely satisfactory operation is obtained even if the resistance through the stop-motion contact circuit with the metal bar is as high as 500,000 ohms.

The electronic relay stops a beamer almost instantly should any one of 500 threads break. Such relays are equally applicable to beamers handling several thousand threads, and can be used in other industries where dust, lint, and high humidity limit the use of conventional contacts.

OBSERVING MOTION — Many defects in the spinning room of textile mills are concealed by the rapid rotation of the spindles on the frames. These defects include slack bands and tapes, spindles that need

oiling, crooked idlers, split or worn bobbins, uneven or mixed yarn, and a multitude of other possibilities. All these faults can be detected with the Strobotac, an electronic instrument developed by General Radio Company. Providing a rapid and accurate means of directly measuring speeds between 600 and 14,400 revolutions per minute and, by indirect methods, speeds up to at least 50,000 revolutions per minute, the unit is particularly adapted for checking speeds where the end of the shaft is not accessible or in cases where the power is limited. It can also be used for stroboscopic observation of moving objects.

This electronic instrument consists of a flashing lamp, a power supply, and an oscillator for controlling the rate at which the lamp is flashed—all in a single assembly. By turning a dial graduated directly in revolutions per minute, the frequency of the oscillator and hence the flashing speed of the lamp can be adjusted to any value between 600 and 14,400 per minute. In use, the instrument is held so that light from the lamp falls on the part to be observed, and the knob is adjusted until the moving part appears to stand still. When this point is reached, the speed may be read directly from the dial.

If the dial is set at twice the actual spindle speed, two images will be seen. The moving part is then carefully observed for any apparent motion which would indicate an abnormal operating condition.

One textile expert estimates conservatively that use of the instrument permits an increase in spinning room production of 3.5 percent with no increase in cost per pound of yarn. At the same time, it permits production of yarn of better quality, with a reduction of from 1 to 2 percent in second-grade yarn.

HIGH-FREQUENCY STEAMING — The twist of rayon yarn for automobile tires is now set in several plants by high-frequency heating units and in a fraction of the time normally required by other methods. Also, greater uniformity of twist is obtained.

The heating units are 15-kilowatt electronic power generators used with specially engineered applicator equipment. To set the twist, cones of rayon taken from the twister are wrapped in wax paper so as to form a fairly water-proof package. The cones are then placed in an inverted position on a wooden block attached to an endless conveyor belt. Each block has two holes drilled to permit the tops of two cones projecting from the yarn-packages to be inserted. The conveyor belt, moving



Cones of twisted-rayon tire cord, wrapped in waxed paper to hold moisture, are passed through high-frequency oven to set twist. Heavy, hard-to-handle fabrics may be dried easily in roll form by electronic heating methods

at a rate varying from three to nine inches per minute, carries the cones into a cage.

In the cage the cones pass between a solid copper bottom plate which, with the cage, constitutes the "cold" or ground electrode, and a top plate that serves as the hot electrode. Between these two electrodes exists the high-frequency electrical field which causes the moisture within the yarn on the cones to vaporize. The wax wrapping holds the moisture and in effect steams the yarn, thus setting the twist.

The "hot" electrode of the electronic power generator is a copper grid placed about one inch above the tops of the cones on the 30-inch conveyor belt. This grid design prevents condensation of moisture which would drip and possibly cause arcing. Most units have plates which average 10 to 20 square feet in area and workers are protected from the "hot" electrode by a housing or cage about eight feet long which covers this part of the conveyor.

Radio-frequency voltage across the load is of the order of 10,000 volts, and the temperature rise in the load is about 100 degrees, Fahrenheit, depending upon the type of rayon being treated. The frequency between the plates ranges from 2 to 10 megacycles and causes agitation of the molecules of the rayon, generating heat by means of molecular friction.

Output of an electronic twist-setter of this size runs about 18,000 to 25,000 pounds for a 24-hour day. Output of smaller size units is correspondingly less, these being available in ratings of two kilowatts and greater.

Textile plants tests so far conducted with electronic heating equipment show that resin-impregnated fabrics may be cured either in roll form—the entire roll of fabric being placed in the dryer—or in

long, flat, continuous lengths. Curled selvages are eliminated by this electronic form of drying. Also, uniformity of curing is obtained because temperature may be controlled accurately. The resin deposited on the innermost section of the fabric structure receives the same degree of heat as that on the outside. Laminated fabrics can likewise be cured in roll form, the same advantages being gained in curing impregnated fabrics.

It is because of this great versatility of electronic applications—testing, protective devices, equipment maintenance, and heating, among them—that the textile world today looks to electronics for even greater aid in performing delicate operations at ever-greater speeds

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PLANT-TRUCK "INTERCOMS"

Boost Efficiency of Hauling Operations, Reduce Confusion

IN THE several-acre large Toledo plant of Spicer Manufacturing Corporation, power-driven trucks for moving materials were constantly getting lost in the shuffle. Quick communication was needed between operators of roving empty trucks and a central point from which trucks could be sufficiently dispatched. An intercommunications system, made by Executone, Inc., solved the problem.

Seventeen substations, each with an intercommunicator, were located at strategic points to give complete coverage of the plant. Each truck operator, on completion of a job, pulls up to the nearest station and calls the dispatcher to report that he is ready for another assignment. In the morning, each driver takes his truck to an assigned substation and waits there for the first order of the

day. With this system much time is saved and all trucks are utilized more efficiently.

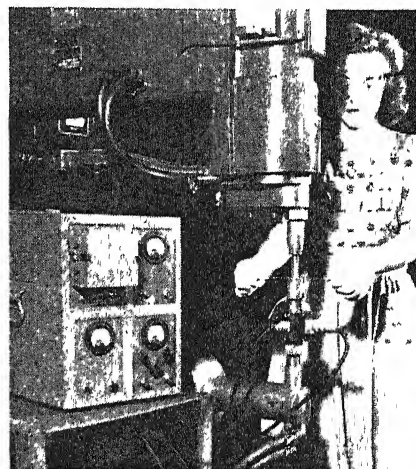
The simple, electronic communication system gives practically all the advantages of having two-way radio on each truck, yet costs much less.

ALUMINUM WELDING

Too Fast for Eyes, Checked By Electronic Detector

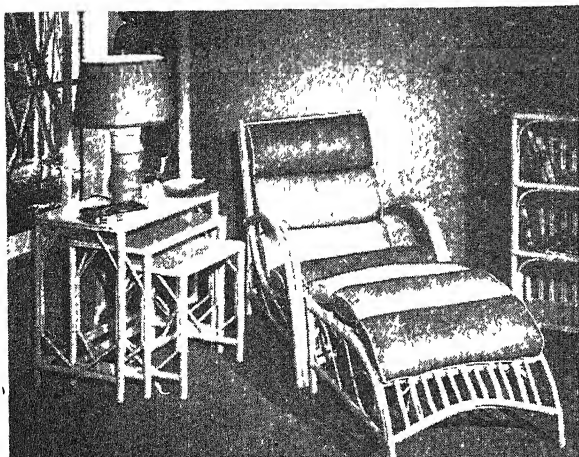
RESISTANCE-WELDING machines used in fabrication of aluminum primary structures for aircraft must be checked monthly to insure meeting specifications for this critical industrial welding application. The fact that the entire welding cycle requires only a fraction of a second, during which several events occur that must be accurately timed, makes visual inspection of finished work impractical as a criterion for correct adjustments of the controls. A new electronic technique known as current-force recording has solved the problem by making available to the operator a pictorial record of each change in current magnitude and weld-squeezing force during the split-second duration of a weld.

Application of electronic monitoring to a welding machine involves



Recorder at left of welding electrodes gives detailed history of each weld as a check on adjustment of controls

substituting a special electrode holder on which are resistance-wire strain gages for measuring forging pressure and a meter-shunt for measuring welding current. These detecting units are connected to an amplifier-oscillograph unit capable of making six different traces simultaneously on 3½-inch wide photographic paper or film that is pulled through by a motor at a speed of approximately 10 inches per second. The detecting-recording instrument is made by General Electric Company.



Courtesy Ficks Reed Company and Textile Leather Corporation
Water- and stain-proof—a vinyl-covered lounge chair

Covering Up With Plastics

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

DESIGNERS and manufacturers in wide variety are today concerned with what kind of covering may best be used in their products. The covering problems involved range from upholstery for domestic furniture to passenger-car, taxi, and truck paneling and seats; from suitcases, camera cases, golf bags, and footballs to decorative surfaces used in restaurants, theaters, and institutions.

The number of products in which the consumer expects colorful and efficient protective coverings grows larger by the day. And according to many of the top authorities in the industries supplying material to cover this wide assortment of merchandise, one answer lies in more and more plastics—supported and unsupported vinyl sheeting—for all of these applications and many others as well.

BY ANOTHER NAME — Plastics upholstery is not new. In the past it has been known under such diverse names as artificial leather, leathercloth, leatherette, art leather, and others that connote simulation of leather. In existence for 30 years or more, this type of plastics upholstery consists of a fabric base coated with nitrocellulose and generally known as pyroxylin. It is used as upholstery largely for flat slip seats on stools, dinette chairs, hassocks, office chairs, metal furniture, theater seats, and outdoor furniture. In the automotive industry it is used for kick pads, trim, and seat upholstery.

Rubber-coated fabrics have also been used extensively in upholstery for institutional furniture, truck cabs, and other applications where heavy-duty service is encountered. But with the advent of vinyl resin in large quantities, coupled with ex-

Possessing a Trio of Virtues—Beauty, Durability, and Easy Handling in Fabrication—Vinyl Covering Materials are Proving Themselves to Be Husky Competitors in the Upholstery and Protective-Covering Field

pert knowledge of its processing, acquired by manufacturers during the past few years, plastics have found a wider field as an upholstery and covering material. And the upholstery and coverings fields have found a new and capable material.

Just how important the vinyls can be in this, and in other fields, is evidenced by the fact that today vinyl-resin production is greater than that of any other group of plastic resins, with the exception of the phenolics. The latest production figures issued by the Bureau of Census indicate that 12,000,000 pounds of vinyl resin were turned out in just the one month of March 1946; and the producers say they are months behind in their orders.

VINYL UPHOLSTERY — The vinyls used for upholstery are the higher chloride content, heavier molecular-weight resins such as The B F Goodrich Chemical Company's Geons or polyvinyl chloride, and the Bakelite Corporation's vinyl chloride-acetate resins known to the trade as VYNW. Another is polyvinyl butyral as produced by the Monsanto Chemical Company and E. I. du Pont de Nemours and Company, Inc. And still another is vinylidene chloride or Saran, manufactured by the Dow Chemical Company. This last named has quite different characteristics and is produced in the form of monofilaments that are subsequently woven into a cloth which enjoys wide popularity as upholstery.

The lighter weight sheeting or film and the finer monofilaments

• LOOKING AHEAD •

Strong popular welcome for upholstery fabrics with transparent coatings that "wipe" clean. . . Less shabby furniture in industrial reception rooms and offices because plastics coverings hold color clear through. . . Wide substitution of vinyl for rubber coatings; advantages are resistance to oil and grease. . . Extensive application in institutions, theaters, restaurants where sanitation is vital factor.

which are beginning to make their appearance in such diverse forms as luxurious brocades and table-cloth covers are not discussed here for the very reason that their range of applications is so varied as to merit separate treatment.

Beauty, durability, and ease of maintenance and handling are the characteristics which manufacturer and consumer alike seek in covering materials of all types. And beauty, durability, and ease of maintenance and handling are definite characteristics of vinyl material—be it in sheet, coating, or woven-fabric form.

Processors and manufacturers report that service tests indicate that no material heretofore used has had the same three-fold ability to withstand flexing, folding, and abrasion. Some materials might be better in one category but none in a combination of all three. A properly plasticized compound on a fabric backing, for example, has been known

to resist more than 1,000,000 flexings in comparison to previously used coated fabrics that flexed from 50,000 to 500,000 times before breaking. The trend here, as in other fields ("Tests or Traditions" Scientific American, October 1946), is away from mechanical tests in favor of actual-use tests where the material is put in a taxi cab or on a piece of furniture that gets rough usage in some such place as a company reception room.

But whether in the laboratory or on furniture in constant use, vinyl leaves no doubt of its age resistance which is undoubtedly its most remarkable characteristic. A specimen of almost any age can be made to look like new by washing. It has been exposed to more than 800 hours of Florida sunshine and 200 hours of activated ageing in various testing machines without showing loss of any of the brilliant color that is such a selling point with the ultimate consumer. Cracks that are the inevitable result of ageing in many other materials do not show up in properly processed vinyl sheeting, for example, at any age. To the end, vinyl sheeting retains its soft, luxurious feel that is so different from that of any other material.

Ease in cleaning is usually a selling point no matter what the ultimate use. Vinyl upholstery and cover materials can be washed with soap and water; ink, grease or oil, blood, medicine, fruit juice, acids,

and a score of other soiling mediums can be wiped off without leaving a trace. The sheet vinyl is waterproof and particularly resistant to salt spray, a fact which widens the possible uses to include boat upholstery and seashore cottage furniture.

Another valuable property of vinyl-chloride materials is that they will not support combustion. If maximum flameproofing is desired, special compounds can be used so that the material will not burn even when held directly over a flame.

Each of the vinyl upholstery materials has its own peculiar merit

which can best be brought out if each type is dealt with separately.

SUPPORTED AND UNSUPPORTED FILM

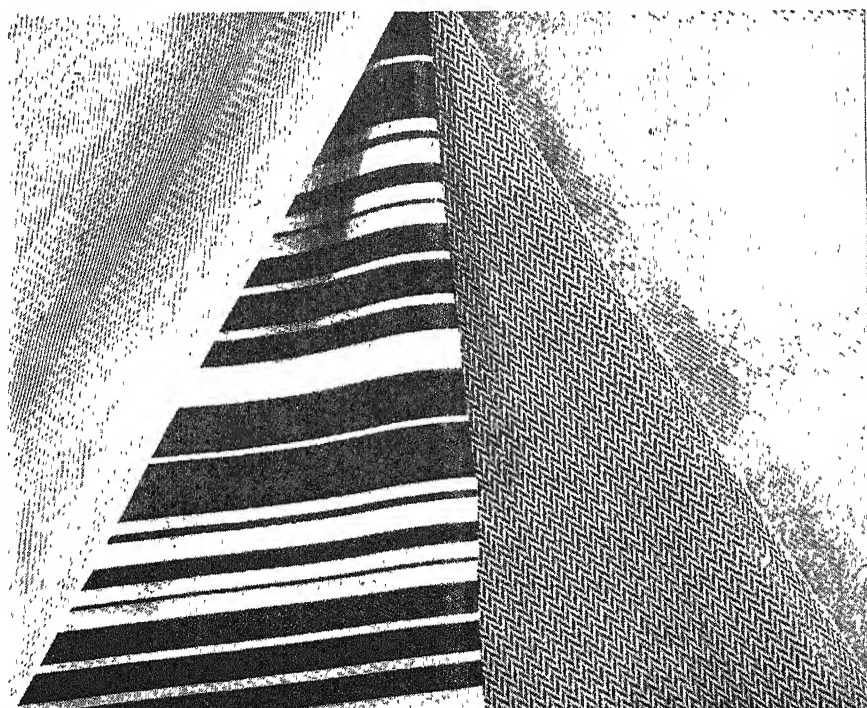
Film-type vinyl upholstery may be either a coated fabric or an unsupported film. Many upholsterers advise that both supported and unsupported vinyl sheeting are easy to work with because they cut like fabric, can be easily draped, and there is little waste compared to that involved when cutting leather. Also, scraps can be used for trim and decoration.

It is questionable whether vinyl supported or unsupported sheeting



Courtesy Pantasote Company, Inc.

Vinyl-fabric wall covering (right) is productive of unique color and space effects. Saran-monofilament textiles (below) clean readily and wear long



Courtesy The Dow Chemical Company

will ever supplant leather in top-grade upholstery. A long-standing partiality exists toward leather for certain uses. There are, however, all kinds of leather and the less preferred types used in less costly applications will almost certainly have difficulties competing with vinyl.

The competition from natural rubber coatings is not expected to be too severe because, as vinyl processors contend, rubber is not as resistant to oils, grease, and perspiration as vinyl and is faced with the handicap of dull colors. Pyroxylin coatings, however, are expected to continue to hold a large share of their present market volume because of the price factor and their fitness for many uses not involving severe flexing.

Today, the principal categories of furniture upholstery are slip seats, as in dinette chairs where the upholstery is rigid and drawn tight; the semi-rigid type such as a stiff seat with boxing that does not col-

lapse; the flexible type where the side boxing collapses, and the plant type where cushions are filled with down or sponge rubber

It takes little imagination to see how vinyl supported or unsupported sheeting fits into the requirements of these four types of covering. It is easily worked, and its flexibility makes it easy to fashion around corners, curves, and edges. Also, it can be stencilled or printed to give a fabric-like effect which is of considerable value for interior design in cocktail lounges and other places where a fabric finish is desired but a hard surface required.

Vinyl sheeting can also be used as webbing with tubular aluminum, chrome, or wood for outdoor use. Although designers were of the opinion that webbed furniture was but a stop-gap when materials were scarce, consumers have taken to it and the demand is continuing to increase.

TRANSPARENT COATINGS — The application of transparent coatings to suitable fabrics is something new in upholstery. It enables upholsterers to pick almost any printed figure or dyed fabric, have it coated with clear butyral, and applied to the furniture frame just as they wish. And the consumer won't need to worry about dirt on light-colored upholstery because chairs or sofas may be sponged off with soap and water to remove any stain or spot.

Polyvinyl butyral, the type of vinyl used in this coating, can be applied by calendering or spread coating. It imparts to even the most inexpensive fabrics a soft texture and body not usually found in coated textiles. And the fabric may be washed and ironed frequently. The coating cannot, however, be successfully applied to fabric with a heavy pile such as automobile upholstery nor to any other deep textured material, nor to straight acetate rayon, although viscose can be coated very successfully.

The three principal claims made for the vinyl butyral as a fabric coating are transparency, low modulus of elasticity, and adhesive qualities. After applying this resin, the fabric hardly appears to be coated; yet it is water-proof, stain-proof and highly abrasion resistant. Color possibilities are infinite in either transparents or opaques. In comparison to more elastic rubber, vinyl butyral is a dead material and, when distorted, its recovery is slow. It is this characteristic which gives an extreme softness and warmth of texture to the treated fabric. Moreover, because of the resin's adhesive quality the processor is able to obtain a

quick and comparatively easy bond to difficult fabrics such as glass, Fortisan, nylon, and high-count cottons.

A very new application of butyral is as a coating for upholstery webbing. Yet another is as the coating for twisted paper which is then woven into chair seats and so-called grass rugs. In this latter process, a tissue type paper is slit into streamers one inch wide, then wound and twisted through a cone shaped die from which it emerges in a roll about 1/16 inch in diameter. This paper may be coated with butyral before it is cut or after it is rolled and the resulting material can be handled on weaving machines.

Vinyl upholstery is only just beginning to make itself known in the furniture and covering fields. But its success thus far with both the manufacturer and the public is encouraging. In fact, the word "plastics" used in connection with upholstery is almost a guaranteed attention getter. The story is told that at one furniture show an exhibitor labeled his chairs as "artificial leather" without attracting attention while another with the same type material called it "plastics upholstery" and was swamped with visitors



STRUCTURAL PLASTICS

*Need No Timber Support,
Hampered by Building Codes*

WITH THE current urgency of building programs, great stress is being put on the possibility of new materials filling part of the breach caused by the shortage of established building materials. A case in point is the publicity given a structural-plastics material developed for housing by Lincoln Industries, Inc., which has thus far been used in the construction of a number of sample houses, some with four and five rooms, others with nine.

The single thickness panels—the form in which this structural plastics is produced—consist of an expanded plastics core with aluminum faces. Coming in either two- or three-inch thicknesses, the panels are said to have good insulation qualities, high strength, and a weight less than one half that of cork. The honeycomb-like core is made of Kraft paper impregnated with a plastics resin and the cells of the core are bonded to the aluminum skins with a synthetic-resin adhesive.

To facilitate the assembly of the panels to form the walls or the flat

roofs of the sample houses, the sandwich panels are produced with flanges. Because of the light weight of the material it is possible for the walls themselves to carry the weight of the roofs and the panels, doing away with the need for supporting timbers.

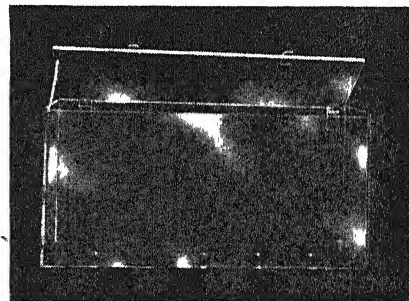
Although the aluminum outer facings of these panels will take paint, the unpainted skins are said to reflect the heat of the sun and add to the cooling qualities of the structure.

Established building codes are today the big stumbling block to the extended use of this structural-plastics panel. Based on conventional materials, these codes require a certain wall thickness regardless of the strength of the material. When this difficulty is settled, however, Lincoln Industries estimates that it can retail a four-room house, made of this structural plastics, for approximately \$3000. This figure is expected to include the cost of kitchen and bathroom equipment, but not the heating system.

PLASTICS HINGES

*Employ Flexible Vinyl,
Avoid Metal and Screws*

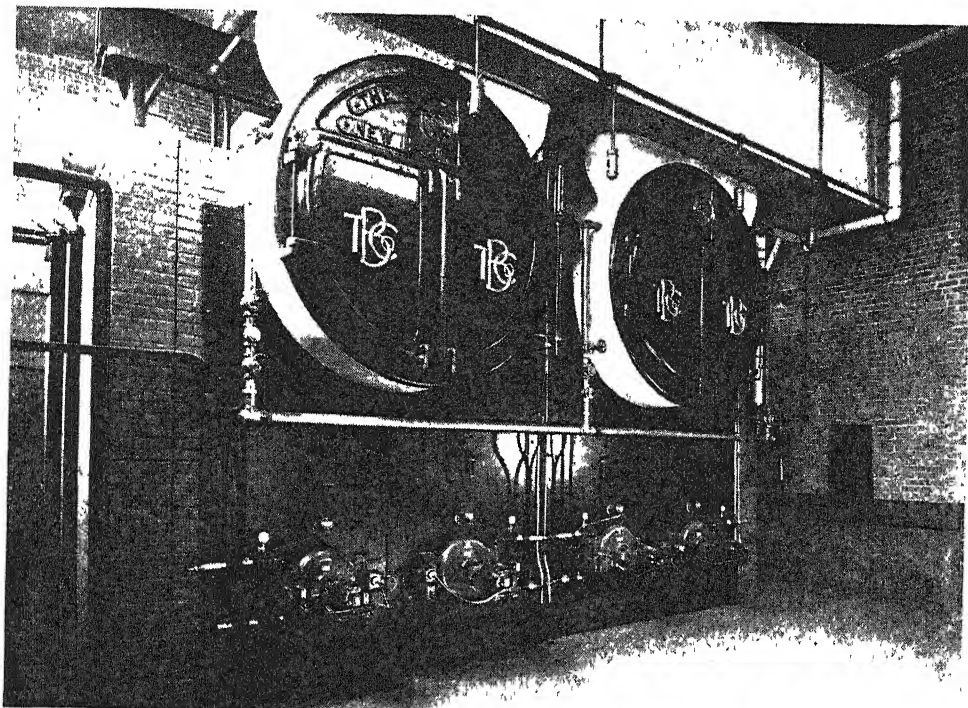
FOR HINGING acrylic boxes without marring their appearance with metal hinges or screws a new method called "hinged Plexiglas" involves laminating Vinylite to Plexiglas, neither of the materials being affected in physical or chemical properties by the process. A thin sheet of vinyl, 0.020 to 0.12 inch, is laminated to a 1/8-inch thick sheet of acrylic. Then the acrylic is sawed



"Hinged Plexiglas" solves a problem in making plastics boxes by eliminating need for metal hinges and screws

through, leaving the vinyl sheet untouched to serve as the hinge.

Amplex Plastics Corporation is now utilizing the process developed by the Willson Plastics Division, Willson Magazine Camera Company, in the production of an acrylic box for the hosiery industry. The box is designed to hold spools of nylon thread which is fed through holes in the bottom of the transparent case.



Heavy-oil burners heat large buildings almost without attention, can be started up or shut down quickly to suit requirements dictated by occupancy of the structure

Oil Heat For Industry

INDUSTRIAL fuel-oil burners are rapidly gaining favor and an impressive number of installations are being made in a surprising variety of trades as equipment becomes available. The reasons and advantages that have prompted this "swing to oil" are not only numerous but also are straightforward and logical. Oil contains more heat units for a given volume than any other common fuel. This point, coupled with the fact that it is a liquid—easily handled with a minimum of manual labor—gives oil the feature of requiring about half the storage space needed for a solid fuel of equal heat content. Moreover, oil may be economically handled even when stored at a distance from the furnace that would be impractical with coal and to industries faced with major waste-disposal problems the absence of ash is a blessing.

Other advantages of oil as an industrial fuel are based on the technical convenience of a fire that starts instantly and allows working steam pressure to build up quickly. Conversely, oil fires can be extinguished immediately. In apartment blocks and public buildings, fully

For Quick, Flexible Heat and Convenient Handling and Storage, Heavy Residual Fuel Oils are Unmatched. Automatic Controls, Now Improved By Electronic Systems, Relegate Furnace Firing to a Secondary Place that Permits Closer Attention to the Actual Processing Work In Hand

By JOHN SMITH

Sales and Research Engineer
Gilbert and Barker Manufacturing Company

• **LOOKING AHEAD** •
Cleaner industrial plants and environs as more firms switch to oil. . . Less space devoted to fuel storage on expensive industrial property. . . Reduction in temperature fluctuations in public buildings and apartments. . . Fewer damaged heating plants as automatic controls reduce the importance of human factors.

automatic burners can be installed so that a minimum of attention is required from operating personnel. Hence the time normally devoted to other types of heating plants can be used on more profitable duties. Similarly, when oil firing is used in such operations as processing furnaces, the automatic burner and temperature controls are a distinct

advantage in that they leave the operator free to observe the process and maintain a closer check on it.

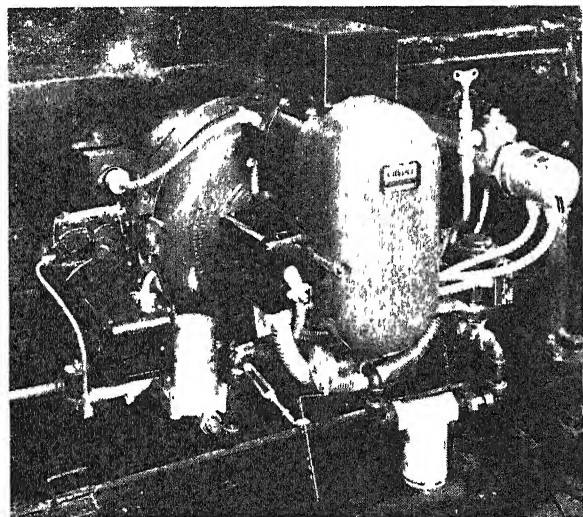
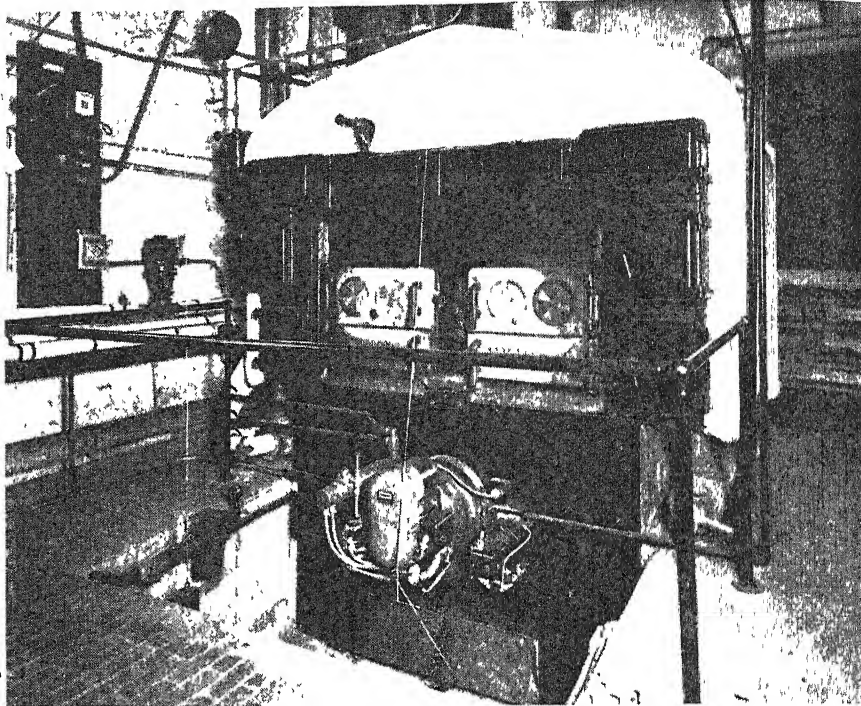
Such technical and convenience features as these have brought oil to ever wider use in industrial processes. Included in this long list of industrial applications are the forging, welding, and melting of metals; baking, hardening, tempering, annealing, bluing, soldering, and enameling in a variety of fields; and heating tanks, lehrs, and cracking-off machines in the glass industry. Chemical and petroleum refineries employ oil as a processing fuel; ceramic manufacturers use it for firing kilns; and oil has become the almost universal fuel for transportation by water.

BURNER TYPES — To exploit efficiently the inherent advantages of oil as a fuel, a considerable amount

of research and experiment has been needed. Although oil burners consuming residual fuel oils have been in use for many years, during most of this period these burners were operated manually or semi-automatically. Fully-automatic operation of burners using residual oils was long considered to be impractical.

Over recent years, however, great progress was made in applying automatic control to heavy-fuel oil burners. This progress was not due to any radical change in burner design but rather to steady improvement of existing types. Improvements in the operation and reliability of automatic combustion safety controls have also been a contributing factor. The result has been highly satisfactory operation of fully-automatic oil burners and a greatly widened field of application for their use.

Residual fuels are classified by Commercial Fuel Oil Standards as



Automatic burner controls, seen on two industrial installations (above and left), obviate need for close regulation by fireman and allow more accurate management of process heat. Electronic circuits are now finding wide application and supplanting older control devices.

the gas-electric ignition system. In this system, an electric spark is used to light a gas pilot. The spark is produced at the tip of an electrode by a high-voltage transformer having an output of 5000 volts and 23 milliamperes in the secondary circuit. A gas valve, controlled by a solenoid coil, opens simultaneously when the spark is started. In the sequence of operation the electric spark lights the gas, producing a fairly large flame. The gas flame is in close proximity with the fuel oil being thrown off the spinning cup; consequently the oil is lighted from this gas flame and combustion starts. After the oil flame is well established, the gas-electric ignition goes off and combustion is maintained by the heat from the fire box and the burning oil.

In the early days of automatic-burner development there were many oil flame failures due to faulty ignition. Here, the application of electronic controls to industrial oil-burner installations has, within a comparatively recent period of time, resulted in vastly improved burner operation, particularly in pilot-light protection. With electronic controls, if the gas flame fails to ignite for any reason, the burner is automatically shut down and cannot be started up again unless the operator makes a visual inspection and corrects the cause of flame failure.

Electronics are also being applied in combustion-safety controls for the protection of the boiler or furnace in case of abnormal conditions. If, for example, the flame should be extinguished or should change from its normal characteristics in any way, the combustion safety control

numbers 5 and 6. They are the products which remain after all of the lighter and more valuable petroleum products have been refined from the crude oil.

Residual-fuel oil burners are classed according to the method used to atomize the oil. The three most widely used types are the horizontal rotary cup, the steam atomizer, and the mechanical-pressure atomizer. In the horizontal rotary-cup type burner, the fuel oil is broken up by centrifugal force; that is, the oil is thrown off the edge of a rapidly spinning, horizontal conical cup. The steam atomizer makes use of the heat and velocity of the steam to break up the oil into small particles. In the mechanical-pressure atomizer the desired effect is obtained by forcing the oil through an atomizer tip at fairly high velocity and pressure.

The horizontal rotary, spinning-cup type of burner is gaining in

favor because of its integral design. From an economical and mechanical standpoint, such a burner has the desirable feature of embodying its own oil pump, motor, fan, and electric oil pre-heaters all in a single compact unit. In practice, the burner mounting plate is secured to the boiler front in such a way that the main body of the burner and housing is hinged, which permits it to be swung out for rapid inspection of the spinner cup and facilitates easy cleaning or removal. Also, when several burners of this type are required in one boiler or furnace a separate oil pump may be used to supply oil to all the burners according to the requirements of each.

ELECTRONICS EMPLOYED — Of primary importance in automatic-burner operation is the method used to ignite the fuel oil after it leaves the spinner cup. The most successful and reliable method appears to be

will automatically shut the burner down. Other controls of this type involve an automatic water feeder and a low-water cut-off device that can be installed for boiler protection. The water feeder replenishes the water supply to the desired level in the boiler, while the low water cut-off functions to shut the burner off in the event that the water level becomes dangerously low.

PUMPING AND STORAGE—Residual fuel oils are difficult to pump at normal atmospheric temperatures. Consequently, heaters must be used to raise the fuel oil to a temperature suitable for pumping. For this purpose a steam or hot-water coil is usually located in the fuel-oil storage tank. A temperature of 100 degrees, Fahrenheit, is generally sufficiently high to permit the oil to flow. To insure proper atomization of the oil a further increase in temperature is required after the fuel oil leaves the pump and before it is admitted to the spinner cup. This may be provided by electrical heaters, steam, or hot-water heaters, or a combination of all three.

The installation details of an industrial oil burner and the selection of the proper sequence of operation varies so widely with various applications that a competent engineer of wide experience must be chosen to do the planning. The proper selection of combustion controls, combustion-chamber design, fuel-oil system, and the type of burner to be used requires careful consideration and expert knowledge in order that the user may receive the ultimate in satisfactory performance.

Fuel-oil storage tanks are an important part of the system. Their capacity largely depends on the

amount of oil to be burned and the methods of delivery. The general practice is to have the fuel-oil storage tank at least $1\frac{1}{2}$ times the capacity of the largest delivery vehicle likely to be used. If Number 6 oil, the heaviest of commercial residual oils is used, it must be delivered hot enough so that it can be pumped. Thus, when this grade of oil is delivered by railway tank car, provision must be made to heat the oil in the car. This is generally done by connecting a steam line to coils within the tank car.

New applications constantly being discovered open broader fields for automatic oil burners using residual fuel oils. Industrial acceptance of such new uses promises to be rapid due to the reliable and dependable performance of heavy-fuel oil burners in many large buildings over a long period of years. Recent improvements in control and operating features have made installations so trouble-free that relatively unskilled personnel can take care of the equipment after a brief period of instruction. Hence there is every reason to believe that the demand for heavy-fuel oil burners will continue to tax manufacturers' production facilities for some time to come.

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PISTON-RING OILING

Studied Under Operating Conditions In Glass Engine

BEHAVIOR of the oil film on the piston of an internal-combustion engine, representing new technical knowledge expected to be directly helpful in designing and constructing motor vehicle powerplants, was

described at a recent meeting of the Society of Automotive Engineers.

Methods and results from two photographic studies of what happens inside the cylinder of an internal combustion engine were reported as providing engineers at long last with exact knowledge of the performance of piston, rings, and oil film during the full cycle of induction, compression, explosion, and exhausting.

Visual studies, using glass cylinders, camera, and both scattered and fluorescent lighting, were described by M. C. Shaw and T. J. Nussdorfer, of the National Advisory Committee for Aeronautics, as revealing that piston skirt lubrication is hydrodynamic for at least part of the stroke and that the amount of lubrication is a function of the relative angular positions of the piston rings and the lateral motion of the piston. It was said that piston rings were observed to rotate as rapidly as one revolution per minute at engine speeds of 1000 revolutions per minute. The oil film on the faces of piston rings was estimated to be only .0001 inch thick, perhaps less.

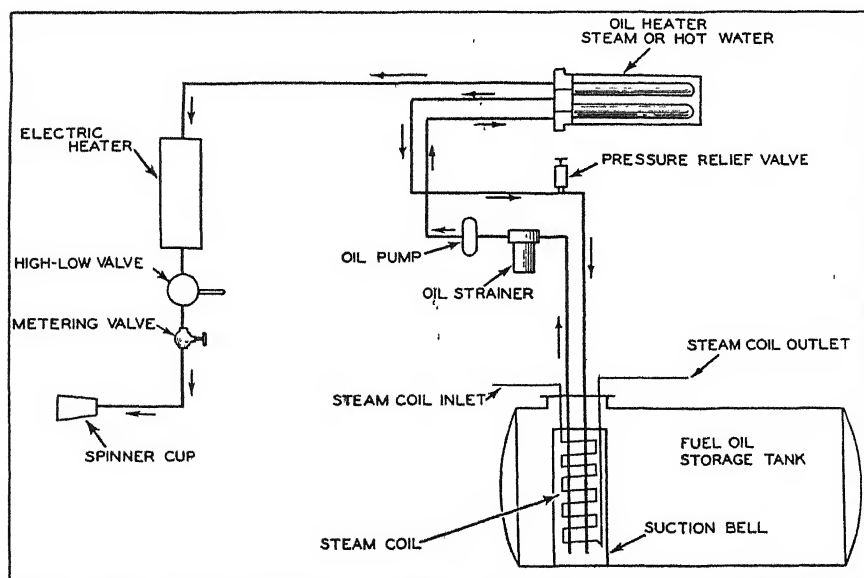
SYNTHETIC FUELS AND OILS

*Tested for Military Use,
Made from Natural Gas*

AN EXTENSIVE line of synthetic fuels and lubricants were recently given full-scale tests by both the Army and Navy. The new synthetics were used to fuel and lubricate landing craft, amphibious tanks, and experimental gas turbine and turbo-jet engines.

The tests were carried out as a part of plans just announced by the Navy for a long-range study of synthetic fuels to be made jointly by the Navy and the oil industry. According to Dr. W. E. Kuhn of The Texas Company, synthetic gasoline is made by an improvement on the Fischer-Tropsch process. Synthetic gasoline of high-octane rating, high-cetane Diesel fuel, and jet fuels can be produced by burning methane — the principal element in natural gas — in an atmosphere of pure oxygen. From this, two gases, carbon monoxide and hydrogen, are obtained which are the building blocks for the synthetic products.

The synthetic grease demonstrates a wider range of operating temperatures than any lubricant previously available. It therefore appears suited for aircraft use in that it will operate satisfactorily between a subzero temperature of minus 65 degrees, Fahrenheit, and a high temperature of 250 degrees, Fahrenheit. This grease is made from 20 percent soap and a special synthetic oil.



Typical flow pattern of heavy-oil storage and feed system indicates convenience of handling without manual labor. Oil takes less storage space than solid fuel

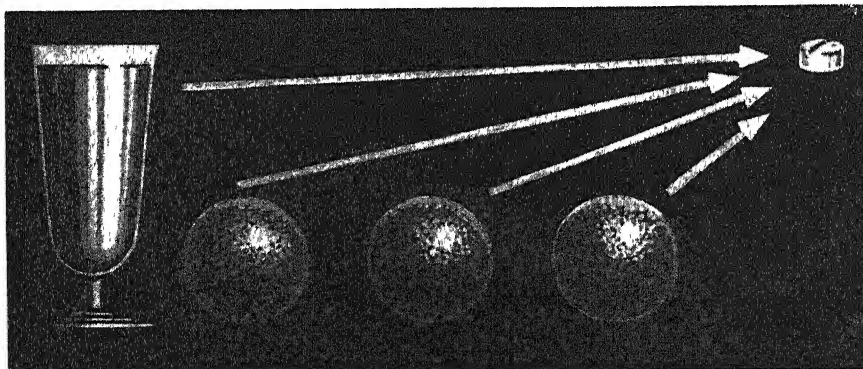
New Vitamin C For Old

In This Best-Fed Nation in the World, One-Third to One-Half of the Population Lacks Vitamin C. This Vital Food Element—Essential for Vigor and Efficiency—Is Now Available in a New Synthetic Form that Eliminates Undesirable Reactions Common to the Older Ascorbic Acid

By BARCLAY MOON NEWMAN
Author of "Must We Grow Old?"

POOLING their ambition and technical genius, the industrial chemist and the medical researcher have succeeded in performing a remarkable feat—at the same time a feat promising improved health, more vigor, and possibly more years not only to industrial employees but also to other millions of people the world over. The feat is remarkable

loss of teeth, subnormal vigor, and probably also acceleration of the processes of aging. To treat chronic deficiency, large doses of "C" must be given over a period of many months. The old "C"—known to chemists as ascorbic acid—is definitely an acid. Hence, in quantity, it often causes an undesirable if not decidedly injurious acid shift in the human body,



Potency of sodium-ascorbate tablets is demonstrated graphically in terms of equivalent vitamin-C activity from other sources. On this basis, one tablet matches three large oranges—about eight ounces of juice—or 13 quarts of milk

because industry has turned into reality an ideal of the medical world: to bring to mankind a synthetic chemical—a new form of vitamin C—that improves upon Nature's original design for this vitamin eaten by man for untold years.

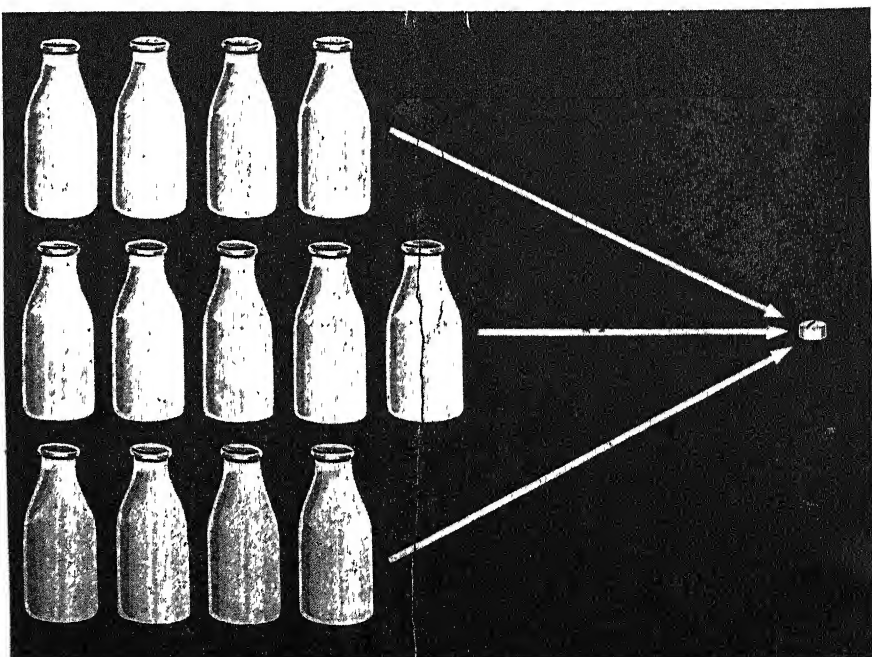
The discovery of the new vitamin by Dr. Simon L. Ruskin, a distinguished medical scientist, and its mass production by the chemists of the Van Patten Pharmaceutical Company, are timely. Recent surveys sponsored by the United States Public Health Service, the Rockefeller Foundation, and the Milbank Memorial Foundation have disclosed that chronic deficiency of vitamin C is surprisingly common in the United States—more common and more serious than in the instance of other food factors. Results of the deficiency include gingivitis (gum inflammation), early

• LOOKING AHEAD •

Future generations unplagued by tooth and gum deterioration . . . Vitamin therapy by industry, cost to be offset by better worker health, greater output . . . Possible reduction in premature senility in a population now growing older . . . Less unintentional and unrecognized malnutrition from food-handling and preserving methods that destroy vitamins.

swinging the system too far from the normal, slightly alkaline side. It also irritates the delicate membranes of the gastro-intestinal tract. And many people are allergic to both natural and synthetic ascorbic acid.

THEORY TO REALITY --- As early as 1933, immediately after the discovery of the chemical nature of ascorbic acid, Ruskin began to experiment with new combinations of the acid and *metals*. He thus pioneered into a novel world of therapy—chemotherapy with the metallic salts of ascorbic acid. After years of investigation, Ruskin was able to determine that tablets of sodium ascorbate—ascorbic acid neutralized by union with sodium metal—have the same physiological



and therapeutic activity as the old "C" but do not have the same undesirable side-effects. A new "C"—far better than the "C" of the past—was thenceforth available to mankind—theoretically. There were many technical obstacles between theoretical discovery and practical application. The dream of the theorist had to be transmuted into practical reality by the art of the industrial scientist.

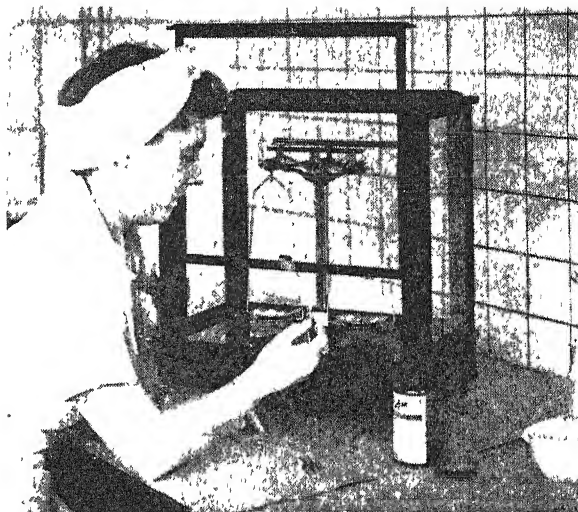
Here it was necessary to work out the problems of practical production methods. The technicians developed successful manufacturing processes based on the formation of the neutral salt, sodium ascorbate, by combining ascorbic acid and sodium under anhydrous conditions. Acid and base yield salt and water, according to the elementary textbooks. Why not simply neutralize ascorbic acid with sodium-containing base in water solution, then evaporate to dryness, to obtain the dry powder mass of sodium ascorbate crystals? Ascorbic acid is a very sensitive chemical: in brief, it is too unstable to be dealt with in this way and the salt-forming reaction must be conducted in water-free methyl alcohol. A series of relatively complex operations must be carried out before the new vitamin C precipitates as a pure, white crystalline mass. Sodium-ascorbate tablets are produced from these crystals by standard precision tablet-making machines.

Each tablet is scored to permit ready adjustment of dosage—especially advantageous when supplementing the diets of babies and small children. Unlike acid "C," the tablets have a pleasant malty flavor and can be chewed like candy—a practical feature in the cases of individuals who have difficulty in swallowing any kind of tablet or pill.

SAFER AND MORE POTENT — Because of its unusual value in chemotherapy of "C" deficiency and in relation to public health, the new vitamin has been given speedy official recognition: it has been incorporated in the new edition of the Pharmacopeia of the United States. By now, sodium-ascorbate tablets are known to most doctors and dentists. Chemically neutral, they cause no shift in the human chemical system, do not unbalance it toward the acid side. They are less irritating to the gastro-intestinal membranes than is ascorbic acid, hence can be safely given in the large doses now generally prescribed for reversing the changes wrought by prolonged "moderate" deficiency.

Doses as high as 1000 to 2000 mil-

Technician weighs
finished tablets
carefully on accurate
chemical balance.
Each sodium-
ascorbate tablet
contains 120
milligrams. This is
equivalent to
100 milligrams of
vitamin-C activity



ligrams per day are administered in many cases—more vitamin C than could be obtained from dozens of oranges per day, or scores of tomatoes, or 100 quarts of milk.

Natural vitamin C is readily destroyed by oxidation—a half hour in the sun on the doorstep, and a bottle of milk has lost its vitamin-C content. Expose orange juice to air—in or out of the refrigerator—and soon most of the "C" has been oxidized by the oxygen of the air. "C" disappears during storage, canning, and cooking of vegetables and fruits; it gradually disappears from the cans on the grocer's shelf as well as the vegetables on the fruit stand. Normal eating of the old "C" in food results in much of it being oxidized in the digestive tract, the intestinal flora participating in this destruction of the indispensable food factor. Sodium ascorbate, however, is far more stable, and may be kept indefinitely in the form of tablets—if in a cool, dark place.

NECESSARY TO HEALTH — Because of the rapid oxidation of the old "C" in foods and beverages, many persons do not obtain all the vitamin they think they are getting. And how many increase their intakes when they take strenuous exercise, or have colds, or suffer from other ills? Increased activity and disease, even such a mild disease as the common cold, markedly increase the vitamin C requirement. And different individuals differ widely in their needs for "C"—old or new. For these reasons, as surveys have shown, between one third and one half the population suffers from mild "C"-deficiency. Probably most persons intermittently permit their levels of "C" to sink below the optimum.

Industrial workers by the thousands have been found to suffer from effects of sub-optimal intakes of the vitamin. In many cases, such

deficiency leads to gum inflammation and actual loss of teeth at an early age—because of pathological changes in the supporting structures of the teeth. Also, "C" deficiency predisposes to pyorrhea—a definite although recently established fact. Other results of lack of "C" are of great importance to industrial workers. Accidents do occur, and when the body has very low stores of "C," wounds heal slowly or fail to heal—until the vital food factor is provided in sufficient quantity. Further, as recent investigations at Columbia University's College of Physicians and Surgeons indicate, the "C"-deficient body does not have the same capacity to resist and counteract the effects of shock—as in accidents—as does the human system with a normal level of the vitamin in the tissues.

Other studies have indicated—though not established—that the duration of the common cold is briefer in those with normal levels of "C." Theory would lead us to expect such discoveries. The need for the vitamin is greatly increased by infection and fever, and resistance to certain types of infection—particularly of the gums and supporting structures of the teeth—is definitely lower than normal in cases of vitamin-C deficiency. Some authorities believe that resistance to *any and every* type of infection is reduced by lack of "C."

AFFECTS LIFE SPAN — More fascinating still are the results of investigations to determine the effects of so-called "mild" chronic vitamin-C deficiency on vigor and length of life. A recent report by Dr. Harry Dayne Kruse, of the Milbank Memorial Foundation, and associates, after years of study of the effects of prolonged "moderate" lack of the vitamin indicates that slow changes resulting from "C" deficiency add up

to rapid aging. They state: "In the past, these chronic alterations have been called senile changes with the implication that senility caused them. But time is simply a dimension over which chronic changes progress. The tissue changes in the chronic form of deficiency disease are of a kind that progresses slowly and insidiously and recedes just as slowly." These investigators add a point which clarifies the great significance of the new "C": "Potent therapy will produce maximum blood levels and entirely restore bodily saturation (with the vitamin) in several weeks but will completely repair the slightest chronic tissue lesion only after many months." Potent therapy means high dosage—and daily administration for many months. Thousands of industrial workers and much of the general population need such therapy—to save teeth, to gain vigor, and add years. There are risks associated with therapy employing the old "C." The industrial chemist, co-operating with the medical scientist, now makes available the new, safer "C"—sodium ascorbate tablets

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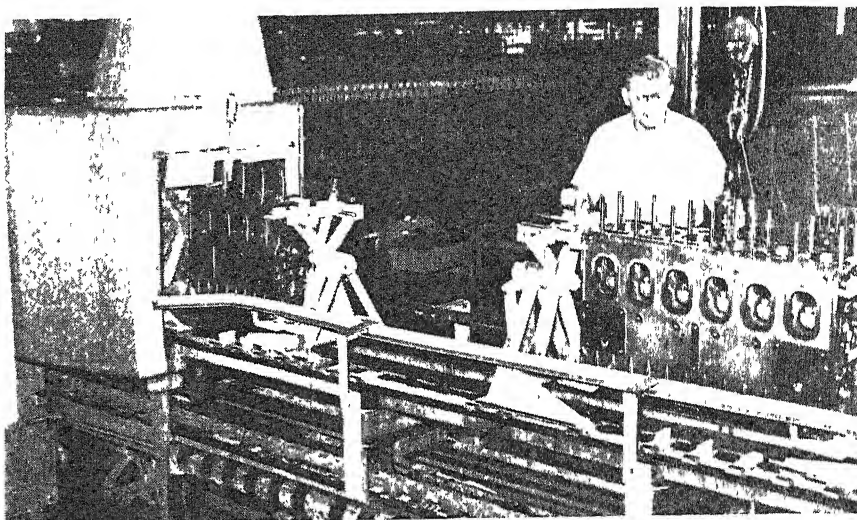
PARTS WASHER

*Insures Thoroughly Clean
Units for Diesel Assembly*

THE CARE and precision which goes into the manufacture of Diesel engines requires a continuous look-out for foreign substances which might easily ruin the close tolerances necessary for best performance. At the Detroit Diesel Engine Division of General Motors Corporation, for example, vacuum cleaners are used continuously to remove the dust and dirt that develop in the ordinary process of manufacture. But even this is not enough to have the engine parts absolutely clean for assembly, and further investigation of the problem proved necessary.

First, the places in the plant where the dust was heaviest were located. This was done by placing foot-square pans in different areas, leaving them 48 hours, and then collecting and weighing the accumulated dust. Trouble areas were located near milling and boring machines, and huge fans now operate the "vacuum cleaners" which draw away the fine particles, keeping them out of the air, and letting the heavier chips fall to the base of machines.

With much of the dust thus eliminated, it was possible to devote full attention to more thorough washing. Previously it had been the prac-



Diesel engine blocks are rocked in cradles as they are cleaned

tice to "dunk" parts in a water-and-solvent bath—a manually controlled electric hoist would do the "dunking" in an open vat—and then blow the parts dry with manually directed streams of compressed air.

Although this process loosened much of the dirt, the pieces being washed weren't turned so that the dirt would spill out. This was particularly true in the case of engine heads and blocks, which have recesses and channels where dirt could hide unnoticed. Also, it was easy to miss a spot in the drying process, and rust would form where moisture remained.

To correct this condition three automatic-washing machines, one for heads, another for blocks, and the third for smaller parts were installed.

In the head washer, the cylinder heads move in on a roller conveyor, are locked into place on an endless chain, and go through three stages of washing. The first stage consists of thoroughly bathing the cylinder heads in a solution to dissolve oil or grease. The solution is projected at the cylinder head from a revolving cylindrical rotor containing a slot lengthwise from which the cleaning mixture is thrown by centrifugal force. The second stage consists of passing the head through the same type of washing action, but a clear, hot water which contains a small amount of inhibitor to prevent rust is substituted for the solution used to dissolve grease. This produces a head that is free of dirt and the heat from the preceding operations plus an air blow-off at the end of the washer produces a clean, dry cylinder head.

During the process the heads revolve—32 times in all—so that cleaning solution, the rinse, and the air reach all nooks and crannies. The blocks go through the same process on conveyor cradles, but instead of

turning, they are inclined from side to side. Smaller parts are washed on conveyor hooks, the parts being placed and slanted so as to come into full contact with the water and air.

STEEL ON FARMS

*May be Made Economical
For Building Construction*

RESEARCH in the construction of steel frame farm buildings by welding, conducted on a long-time basis by the University of Wisconsin through a grant by Carnegie-Illinois Steel Corporation, and broadened by engineers of the steel producer itself, points toward low-cost barns, silos, and cribs, as well as dairy, poultry, and other buildings, which may be quickly erected from materials that should be comparatively plentiful in the post-war period.

For several years Carnegie-Illinois has sponsored research to determine the functional requirements of dairy farm buildings, and to make steel a practical and inexpensive building material for farm use. One of the results of the studies is a new "Site-Welded System of Construction" that makes steel farm buildings competitive with those built of other materials and at the same time opens a broad new avenue of jobs for trained welders and a market for welding equipment.

No attempt is being made to limit the use of materials for this field of construction strictly to steel. Other materials are used where they can be employed more economically and to functional advantage. In fact, the structures being designed by Carnegie-Illinois combine economically several building materials—lumber, asphalt, asbestos, cement, and others—assembled on a basic steel structure.

In the construction of many one-story farm buildings having clear

spans from 24 to 40 feet, only nine—and possibly as few as five—sizes of steel members, primarily standard angles, channels, light columns and plates, are needed for framework. If a combination of steel and other materials is used, an even smaller number of steel sections may be required.

The small number of steel members demanded by this type of construction makes it practical for building material dealers, warehouses, builders, and welding shops to carry adequate steel stocks to serve the farm trade. The research engineers believe local builders can use steel economically because it will be readily available from local dealers in standard sizes which may be cut to desired length and quickly, easily, and permanently welded on the job into a great variety of strong structures.

DDT USE

*Not Recommended Over
Freshly Whitewashed Areas*

FRESH whitewash is likely to be sufficiently alkaline to decompose DDT. Hence DDT should not be mixed with whitewash or applied over freshly whitewashed surfaces.

It may, however, be applied over old whitewash which has largely lost its alkalinity. Any decomposition of the DDT under these conditions will be very slow, and its efficiency can be maintained by applications at shorter intervals, if needed.

INDUSTRIAL REFRIGERATION

*Undergoing Continuous Growth
As New Applications Evolve*

RECENTLY developed products in mechanical refrigeration now are lowering thermometers over a range of more than 230 degrees, Fahrenheit, and are performing as many as 200 domestic, commercial, and industrial services, according to current information from this field. Expanded by engineering progress during the war and since, refrigeration's job today is said to begin in cooling air to 80 degrees above zero for summer air conditioning, while the lower end of the scale is not yet in sight.

Various industrial and laboratory operations now require mechanically produced refrigeration down to minus 150 degrees, Fahrenheit, thus accounting for the 230-degree range. Among such operations are "cold treating" of metals, cold testing of products and materials, and many research processes.

Between the two extremes, refrigeration now is provided at nearly

all temperature levels, with the temperatures themselves controlled within narrow limits to keep drinking water cool, for example, at a constant 50 degrees, Fahrenheit, to keep frozen foods "fresh" at zero, or to dry penicillin properly at minus 70 degrees, Fahrenheit. Other commonly used temperature levels are 72 to 80 degrees, Fahrenheit, for air conditioning; 36 degrees, Fahrenheit, for the preservation of food in the refrigerator, and minus 10 to minus 35 degrees, Fahrenheit, for the fast freezing of foods.

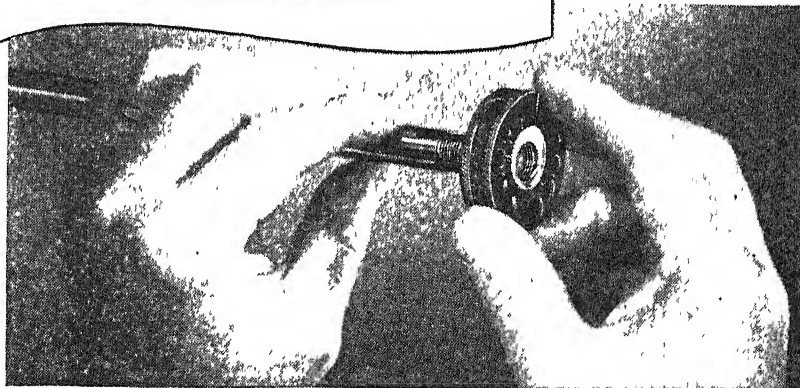
Uses of sub-zero refrigeration in industry have multiplied rapidly, and some of them are becoming standard factory practices. In some

industries, it is reported, "cold treating" of metals has become, in effect, a continuation of the heat treating process with resultant greater ductility and longer life. Temperatures down to minus 120 degrees, Fahrenheit, are employed, with the lower limit usually between minus 80 and minus 120 degrees.

Construction of cold chambers, all-weather laboratories, and stratosphere test units, most of them used in airplane development, has been a leading factor in the extension of sub-zero applications of mechanical refrigeration. In addition to improvements in refrigerating equipment itself, advances in insulation have aided the industry in developing

Ingenious New Technical Methods

To Help You with Your
Reconversion Problems

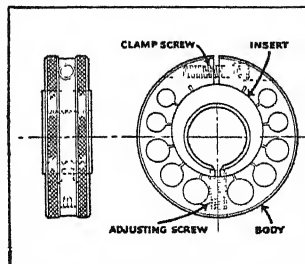


New Thread Ring Gage Starts Round Stays Round With Every Adjustment!

Employing a new principle of design, the Woodworth Thread Ring Gage closes in round within .0002 maximum after .005 adjustment. It offers greater accuracy and stability since size adjustment is controlled along thread helix angle. Threads are held securely in alignment after adjustment, due to unique adjustment means. Wear is distributed over full circumference for all resettings, thus increasing life of gage.

Positive adjustment makes it almost impossible to change setting with ordinary knocks. Positive identification by a green "go" gage and red "not go" gage saves operator time. Aluminum alloy outer body cuts weight in half, to reduce operator fatigue and increase sensitivity.

To also reduce fatigue on precision jobs, many plant owners make chewing gum available for workers. Tests show that the act of chewing aids in relieving tension, which is often the cause of fatigue. These tests further reveal that chewing Wrigley's Spearmint Gum, for instance, helps workers stay alert, thus increases their efficiency to do more accurate work.



Woodworth Thread Ring Gage



You can get complete information from
N. A. Woodworth Company
1300 East Nine Mile Road, Detroit 20, Michigan

AA-93

more efficient products ranging from household refrigerators to cold-storage warehouses and large-scale air-conditioning projects

PURE AIR IN RAIL CARS

Obtained by Activated-Carbon Filtration Unit

INCREASED passenger comfort resulting from a new method of maintaining uniform air "quality," or purity, is promised for railroad cars now being built. By constantly circulating the car air through activated carbon, odors are said to be eliminated.

Odors in railroad cars come from a variety of sources — from smoking, food and drink, and occasionally from the passengers themselves. Heretofore, the railroads were powerless to remedy such odors; this was chiefly due to the lack of space for adequate air-conditioning apparatus. Also involved is the element of weight, an important consideration since cars must carry their air-conditioning plants "on their backs" — each car having its own separate equipment. Hence, the capacity is lacking to treat the outdoor air that must be drawn in if odors are to be kept down or "diluted" and to maintain proper car temperatures at the same time.

In the cars now being built, fresh ventilation air will be obtained from the air within the car itself without requiring additional heating and cooling machinery. The carbon-filtered air increases by two and one-half times the former supply of ven-

tilation air. Air that is recovered — purified — through activated carbon is said to be often cleaner and fresher than outdoor air.

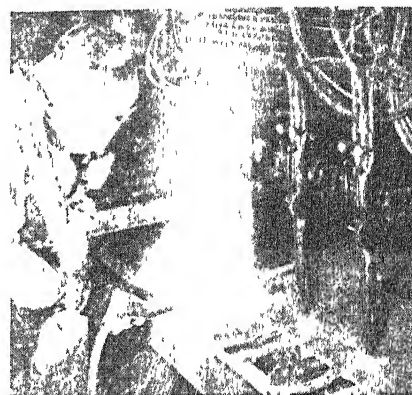
Granular, activated carbon, the term for carbon that has been specially treated to remove extraneous matter, has a powerful attraction for gases and vapors — odors. When these gases strike the carbon surfaces they condense and cling to them until the carbon reaches a state of saturation, usually when the weight of the condensed gases is about 20 percent that of the carbon. This process is known technically as "adsorption." When the carbon becomes saturated it is re-activated or freed of its stored-up impurities so that it can again be used. Activated carbon is a powerful adsorbent agent because of its porosity which provides a vast surface area—it has been estimated that in the type of activated carbon used in air conditioning one cubic inch has a surface area of approximately five acres.

Carbon air purification has been used successfully in large industrial plants where conditioned air is recovered and re-used, a considerable factor in conserving materials, fuel and energy.

FLAME-CUTTING DISTORTION

Minimized by Arc Weld Follow-Up

AN INTERESTING method of preventing distortion during a multiple-torch cutting operation employs both arc and flame. After the torches



Courtesy Air Reduction Sales Company

Arc-weld "tacks" hold flame-cut plate

have made the cuts in the outer edge of the steel plate, the welder follows along, making arc tack welds at the point of entry, thereby restoring the steel to one continuous strip and precluding the possibility of "walking" or "lifting."

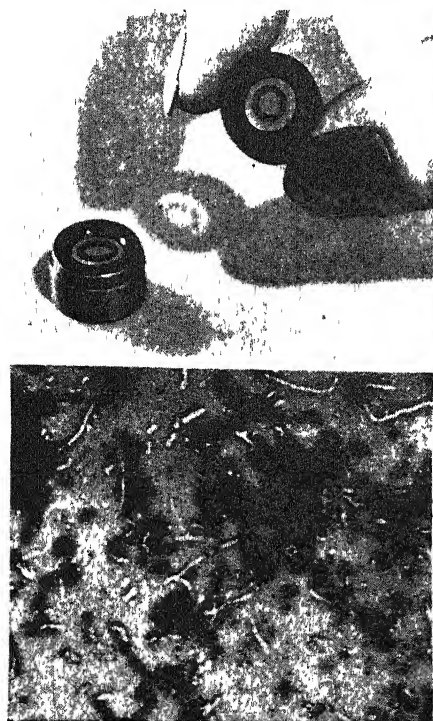
PHASE MICROSCOPY

Makes Transparent Subjects Visible without Staining

TRANSFORMING an ordinary light microscope into an instrument that extends the range of human vision far beyond the limits of present microscopes, new equipment has been developed which permits the observation and study of many living cells, tissues, micro-organisms, and industrial materials so transparent that heretofore little or no detail could be seen in them. This advance in the use of the microscope is called phase microscopy and the converted instrument a phase microscope, according to the American Optical Company.

The new microscope equipment consists of light-controlling diffraction plates which, when placed in an objective lens system, makes detail visible within a specimen by increasing, reducing, or reversing contrast in the image formed by the microscope. One of the features of the phase microscope is that it makes possible an accurate study of transparent living organisms. Formerly, to make them visible it was usually necessary to stain them with dyes, a procedure that kills most organisms. As a result, much of the information gained in the past with the microscope was limited to the study of dead rather than living material.

The phase microscope will be useful in the study of plant and animal life, parasites, emulsions, replicas of metal and other surfaces, glass and plastics transparent surfaces, minerals, crystals, synthetic fibers, and other materials. In the field of industry, innumerable applications are possible; for example, crystals other-



The new phase microscope (right) is equipped with a light-controlling diffraction plate (upper left). Mold fragments (small white objects, lower left), invisible with ordinary microscope, are made visible through the application of phase microscopy

wise barely visible can be seen. In reverse order, regions within certain substances can be made invisible, facilitating the discovery of impurities.

Equipment required to transform a standard light microscope into a phase microscope consists of a diaphragm for controlling light concentrated on the specimen and one of the new diffraction plates placed in the objective lens system. An auxiliary telescope used in place of the microscope eyepiece is helpful while centering the equipment.

Investigations indicate that different types of diffraction plates are preferable for various kinds of investigations. Operation of the diffraction plates is based on the fact that although many materials are so transparent that nothing can be seen with regular microscope equipment, their internal structures usually do have differences in optical path which alter the phase of any light passing through them. The material and size of the parts of the specimen produce the optical path differences. In phase microscopy the specimen is first illuminated by a hollow cone of light and a diffraction plate inserted within the microscope objective. Depending on the kind of diffraction plate, any regions within the specimen of different optical path can be made bright on a dark background, or dark on a light background. The invisible phase differences of the light are converted into illumination differences to which the eye is sensitive.

INDUSTRIAL X-RAY

*Will Penetrate 10-Inch
Steel Pressure-Vessel Walls*

INSTALLATION of a large X-ray machine—2,000,000 volts—for the purpose of examining welds in pressure vessels, will bring to 12 the number of X-ray machines used for this purpose by the Babcock and Wilcox Company, manufacturers of steam generating equipment. A special building will house the new machine and it will be erected adjacent to the location of the present 1,000,000-volt X-ray unit. The building has been designed to protect personnel from radiation and to make possible examination of the largest size drums made by the company.

Although the apparatus, which was purchased from the General Electric X-Ray Corporation, is capable of operating at any voltage from 1,000,000 to 2,000,000, it will be used principally at the higher voltages to take pictures of heavy welds, four inches thick and over. As compared to the 1,000,000-volt X-ray, the new unit will produce



Weighing 4 ounces of Chicken meat for uniform, profitable Chicken a la King packaging. College Inn Food Products Co., Chicago, Ill.

Quality Chicken a la King in mass production requires real skill, careful processing, and accurate packaging to be profitable. Yet the College Inn Food Products Company is doing this job successfully and profitably. Big, plump chickens, mushrooms, peppers, and pimientos go into this fine product. These ingredients are packed by hand in 12 ounce containers and quick frozen at 40 degrees below zero. Each package contains 4 full ounces of chicken meat (weighing operation illustrated) to assure a uniform package. High speed EXACT WEIGHT Scales are used. If you have a similar operation write for full details today.



THE EXACT WEIGHT SCALE COMPANY

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much clearer pictures in that thickness, and will reduce by half the average time required to take radiographs. It can be used successfully on steel walls 10 inches thick. The specially designed building will be 35 feet wide, 31 feet high, and 81 feet in length. Double walls consisting of 42 inches of sand solidly packed between quarter-inch steel plates will prevent radiation from the unit. The building is planned to provide all possible safeguards to protect not only technicians within the building, but anyone in the immediate area.

An overhead, floor-operated crane will support the X-ray unit and

move it around within the building. The X-ray machine is 5 feet in diameter, 12½ feet in length, and weighs 6000 pounds.

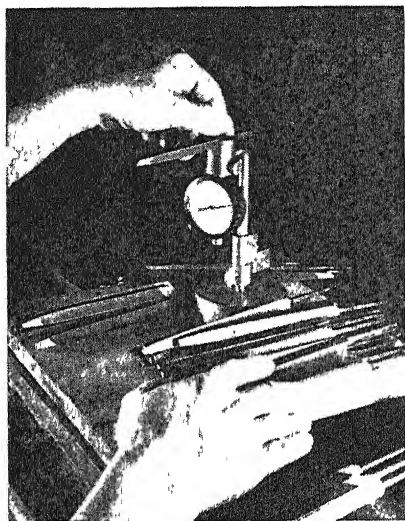
The building will accommodate drums up to 13 feet in diameter and 75 feet in length, which are the dimensions of the largest vessel likely to be shipped by rail. Vessels that weigh up to 150 tons can be tested. This probably represents the maximum weight of pressure vessels that the firm might be called upon to make and test. Two cars with drum turners will bring the drums into the building. One car and one drum turner will be motorized to facilitate handling.

New Products and Processes

DIAL GAGE

*Integral Part of
File Inspection Unit*

FOR precise inspection of Nicholson Files, a dial indicator gage which checks the width of the file to ensure uniformity of this dimension has been designed. The operator, who may be inexperienced, is able to see on the



Accurate checking of file dimensions

indicator dial whether the width of the file is within tolerance or not and, if outside tolerances, by how much.

The Federal Dial Indicating Gage used is a standard unit built into the indicator set-up as an integral part

LIQUID SOAP

*Doubled in Quantity
By Addition of Extender*

A METHOD of extending liquid scrub soaps by 100 percent without increasing fat consumption cuts soap content of the finished product to 9 or 10 percent.

The new formulation not only gives results equivalent to those obtained from standard liquid soaps from the standpoint of detergency, but in addition it adds wetting power, improves rinsability, and is highly effective in hard water.

Although any given formulation frequently must be adjusted slightly to accommodate the particular type of fatty acid base employed by the soap manufacturer, the developer, Rohm and Haas Company, recommends a basic formula containing .4 percent methyl cellulose, 44.5 percent water, 0.1 percent Tamol NNO, 5 percent Triton X-300, and 50 percent liquid potash soap (18-20 percent soap). The formulation gives a clear solution with better viscosity than that of standard scrub

soaps. It has been tested with 20 percent corn-oil soap, 20 percent coconut-oil soap, and standard soaps made with tall and linseed-oil fatty acids. In every case reported the formula did not reduce the foam and gave good results from the standpoint of detergency

EXPANSIVE BIT

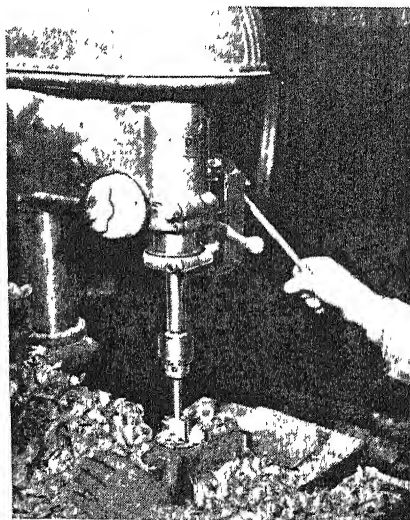
*Fits Power-Tool Drives;
All Parts Replaceable*

FOR USE in an electric drill or drill press, to bore holes $1\frac{1}{2}$ to $3\frac{1}{2}$ inches in wood, a new heavy-duty expansive bit with $\frac{1}{2}$ -inch straight shank is said to embody a new principle in wood-boring tools.

The efficient performance of the tool, called the Bruno Heavy Duty Expansive Bit, is reported to be due to its sturdy construction. The center lip, which cuts away the core at the center of the hole, extends back to form a clamp which firmly holds the adjustable blade at the diameter set. The clamp is locked tight by means of a screw. Once locked in the positive wedge-lock V-groove, the cutter remains securely in place.

Also, a diamond-shaped screwpoint gives longer life by lessening the chance of breakage and the lead-screw is threaded finer than is usual for this type of tool. This latter feature helps pull the bit through the wood, requiring only light pressure to cut quickly and cleanly. The threads are ground to correspond to the capacity of the tool.

The heavy-duty expansive bits are equipped with two cutting blades—one long and one short—to cover the range of the tool and a graduated scale on the blade aids in adjustment. In addition, the fixed cutter, or center lip, cuts away the material at the center around



Bit cutting blade is wedge locked

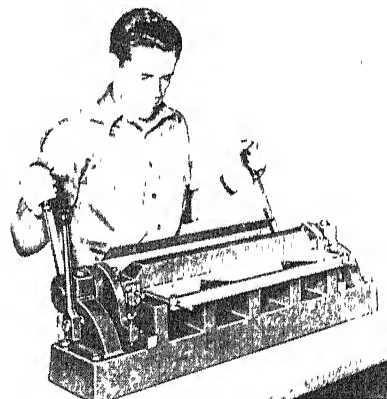
the screw point. The clamping center-lip, being removable, makes possible the easy replacement of all parts. With the shorter cutter, the diameter range is from $1\frac{1}{2}$ to $2\frac{7}{16}$ inches, while that of the long cutter is from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches.

FORMING BRAKE

*Features Precision, High
Output, and Versatility*

MAJOR features now being incorporated in a new model forming-brake include a special material-clamping action which makes possible extremely sharp bends, a double-edge vertical folding plate allowing close reverse bends to be formed, and roller bearings to increase speed and ease of operation. For precision duplication of parts, a quickly adjusted material gage and accurate angular degree stops are also provided.

The tool, called the Di-Acro Brake Number 4, has a material capacity of 16 gage sheet steel and a maximum forming width of 24 inches. It is described as a well constructed unit weighing 285 pounds and incorporating a machine-tool iron base casting to



Clamping action holds material

assure continued accuracy. The brake will rapidly and accurately duplicate complicated parts in many ductile materials, such as copper, bronze, stainless steel, aluminum, bi-metals, sensitized materials, varnished cambrics, and dielectrics.

The original contact surfaces of the Di-Acro Brake can be quickly changed on the job, thereby increasing the working range of the unit to cover the forming of special parts. This feature is said to make possible the forming of shapes and outlines which are often impractical or impossible to duplicate with regular production dies. Also, small parts which are normally produced by large hand or power operated brakes can be formed to advantage on this unit with greater precision and higher production.

WATER-REPELLENT FILM

*Eliminates Effects of Humidity
on Fluorescent Lamps, Tubes*

A NEW material that forms an invisible and permanent "rain coat" over fluorescent lamps and, when used with

metal adjacent to the lamp such as a reflector, makes it practically insensitive to high humidity, is described as the best material yet found to form a continuous insulating film over glass.

The insulating material, called Dri-Film, is applied easily and lamps can be maintained with only customary cleaning. Tests have shown that the lamps, when so coated, not only start faster but also operate satisfactorily even under 100 percent relative humidity.

The water-repellent materials comprise a series of General Electric products made in the course of its developments in the silicone field and were first used for the treatment of ceramic insulators for radio and other communication equipment. The insulators, as in the case of fluorescent lamps, would lose effectiveness when exposed to high humidity.

The company advises that Dri-Film is now being used in an increasing number of applications. One of the most recent was for hearing-aids in which it is used to treat vacuum tubes.

ARC WELDING HEAD

Accommodates Small Electrodes, Speeds Operation

IMPROVEMENTS of the welding head, designed to simplify production installation set-ups and increase speed of operation, are now available for the Lincolnweld hidden-arc process of automatic, metallic-shielded, arc welding. The new, improved head is designated as the LAF-2.

To further expand its use on sheet metal work, the head has been designed to accommodate 3/32-inch electrodes. Equipped with the same lower wire contact jaws as the previous head designated as LAF-1 which accommodates electrode wire ranging from 1/8-inch to 7/32-inch, the new unit also has an extra, movable, tapered contact jaw which can be quickly interchanged if 3/32-inch wire is desired.

The controls have been modified to simplify arc starting. All that is required to start the arc is to turn a single control switch to the "Down Weld" position. This causes the electrode to feed down until the end touches the work piece. Here, short-circuiting the wire to the plate automatically causes the wire feed motor to stop. The flux valve is then turned on and the arc started by means of a push button. The arc is extinguished and the electrode is withdrawn by moving the operating switch from "Down Weld" to the "Up" position.

The Lincolnweld process is designed for use with direct current, utilizing a bare metallic electrode which is fed through a granular flux deposited on the joint to be welded. Sufficient flux is applied to completely cover the arc and the molten metal; the unfused flux is then reclaimed for further use. Successful usages are reported in welding all types of joints including plug, butt, lap, edge, fillet, and corner.

The standard head is changed from butt to fillet welding in a few minutes. In making fillet welds the lower wire

guide and flux tube are changed from straight to curved, thus permitting the head and wire reel to be left in its normal position. The wire is fed in at 40 degrees from horizontal which gives the maximum effective throat for horizontal fillet welds.

INKS FOR RUBBER

Penetrate Surface; Plastics, Enamels, Also Marked

COMPOUNDED for the purpose of trade-marking and imprinting rubber—both natural and synthetic—and plastics as well as for marking enamel and lacquer insulations on wire and cable, several new inks are available in liquid or

paste form. Separate inks are used for each material and the ink for rubber marking can be furnished in a variety of standard colors.

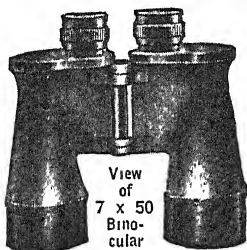
The liquid-form inks are designated as Acro Inks, while the paste-form inks are known as Acromark Inks. Liquid inks are applied by hand or machine, in standard liquid-type ink fountains, and are furnished in various drying characteristics to suit the application. The paste-form inks also are applied by hand, or by mechanical means in standard ink feeds and are said to be as easy to handle and control as regular printers' ink.

In the marking of rubber, these inks are described as permanently penetrating the surface of the rubber and dry-

SENSATIONAL WAR BARGAINS in LENSES and PRISMS

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All Are Achromatic Lenses

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ACHROMATIC TELESCOPE OBJECTIVE LENSES—Cemented. Diam 52 mm., F.L. 8 1/2 inches. Slight seconds.
Stock #6188-S \$3.50 Postpaid
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NEW PROJECT BOOK — HOME BUILT REFLECTOSCOPES . . . 30¢ Postpaid. List of available Telescope Lenses sent FREE with book.

SECONDS IN PLANO-CONVEX CONDENSING LENSES—Diam. 4-7/16", F.L. 6 1/2".
Stock #1068-S 70¢ each Postpaid
RAW OPTICAL GLASS—An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint Glass (seconds) in varying stages of processing. Many prism blanks.
Stock No. 703-S—8 lbs (min. wt.) \$5.00 Postpaid

POLARIZING RING SIGHT (Something New in Optics)—Utilizes the interference pattern created by a basal section of calcite or sodium nitrate crystal between crossed polarizers. Diam 32 mm.—Thickness 7 mm.
Stock #2067-S \$2.00 Postpaid

ACHROMATIC LENSES

Stock No.	Dia in mms.	F.L. in mms.	Price
6158-S*	18	80	\$1.00
6162-S*	25	122	1.25
6164-S*	26	104	.80
6168-S*	29	76	1.25
6171-S*	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	62	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25
6182-S*	27	51	1.25
6183-S*	44	189	2.50

*ASTERISKED ITEMS are uncemented, but FREE cement and Directions included with uncemented sets. USES—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected magnifiers substitute enlarging Lenses, Eye-Piece Lenses, Micro-photography, Gadgets, Optical Instruments, etc. etc.

MAGNIFIER SET—5 Magnifying Lenses. Powers from 1 to 10. Various diam. for many uses. Free Booklet on Home-made magnifiers included.
Stock #1026-S \$2.00 Postpaid

TANK PRISMS—Plain or Silvered 90-45-45 deg 5/16" long, 2 1/4" wide, finely ground and polished.
Stock #3004-S Silvered (Perfect) \$2.00 Postpaid
Stock #3005-S Plain (Perfect) \$2.00 Postpaid
Stock #3100-S Silvered (Second) \$1.00 Postpaid
Stock #3101-S Plain (Second) \$1.00 Postpaid
(Illustrated Book on Prisms included FREE)

MOUNTED PROJECTION LENS

A mounted f 21; 35 inch F.L. Projection Lens mfd on a Navy contract to be used on a 35 mm. Projector. Low reflection coated. Perfect condition. Black finish threaded at rear end. Outside diam. approx 2 inches.
Stock #4031-S \$12.00 Postpaid

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ing in a flexible state to eliminate cracking off or other later deterioration.

The inks developed for marking plastics and enamels are also claimed to combine with the surface of the material and actually become part of it.

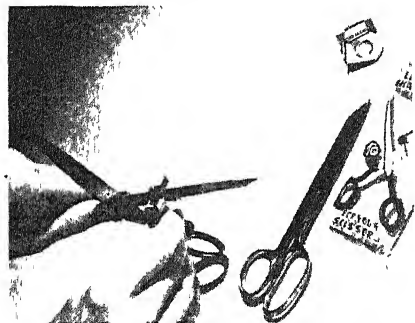
It is noted by the Acromark Company that the success in developing these inks lies in penetration rather than a simple coating, because in most instances a mark must remain a part of the material for the surface life of the product.

SCISSORS SHARPENER

*Assures Keen Edges
at Proper Angles*

MADE in a single stamped and nickel-plated unit, a new scissors sharpener grips a Carborundum stone at an exact manufacturer's angle for producing a keen cutting edge on dull shears and for maintaining the sharpness of new scissors.

In use, one scissors blade is held in the left hand and the flat angle guide of the sharpener is placed against the blade. This brings the cutting stone



A Carborundum stone does the job

down on top of the blade and in position for sharpening. A few two-way strokes are said to be all that is necessary to re-edge a dulled pair of scissors.

The quarter-inch square by one inch long Carborundum stone may be moved forward or backward in the holder and may be turned to any of its four surfaces so that sharpening operations will not wear grooves in the cutting surface of the stone. The device is distributed by South East Merchandise Company.

ALUMINUM PAINT

*Retains Qualities in
Ready-Mixed Storage*

A STABILIZER used in the manufacture of a ready-mixed aluminum paint is reported to give package stability and prevent the paint from darkening in the can even after opening. Also, the paint indicates less tendency to tarnish after application.

Called Chromatone, and intended for indoor or outdoor application on a wide variety of materials—metal, wood, glass, and other hard surfaces—the new paint formula is said to have high protective qualities. Featuring both rust and heat resistance, successful use on heaters,

radiators, tanks, plumbing, and so on is described for the paint by the manufacturer, The Alumetone Corporation.

Good drying and lasting qualities, and a higher percentage of leafing properties which improves hide and adds luster are also claimed. The paint sets in 20 minutes, dries in two to four hours, and may be applied by brush or spray.

NYLON ROPE

*Resists Deterioration, has
Elasticity, Strength*

OVER 29,000,000 feet of nylon filament is contained in 100 feet of 1/2 inch-diameter nylon yacht rope. This impressively large figure indicates the ultra-fineness of a filament of nylon.

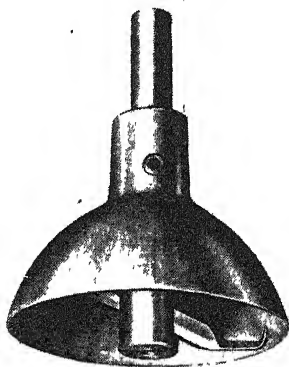
Nylon yacht rope is said to possess many distinct advantages, including higher tensile strength, greater elasticity (which makes it valuable in an anchor line for easier riding and safer tension), resistance to rot and marine decay, and ease of handling. Dry or wet, nylon, it is reported, does not get stiff or hard, or jam in blocks. Also, it can be stored even when wet and will not deteriorate in storage lockers. Longer wear and greater beauty are other advantages.

According to Plymouth Cordage Company, nylon ropes are also being used by ranches and rodeos as lariats. On mule spinners in textile mills, it has been found that nylon drive ropes reduce machine shut-downs.

ROTARY PLANER

*Cuts Wood, Metal, Plastics
Without Tearing*

QUICKLY fitted to any drill press, a new Safe-T-Plane, will plane, rout, panel, bead, or rabbet to any depth in wood working materials. Positive cutting action of the high-speed steel,



Above: View of the cutter of the new rotary planer. Right: The planer in use in a standard power drill press

shear-type blade is said to eliminate scraping or tearing in hard, medium, or soft woods, including balsa, irrespective of grain position. A special cutter is available for making square-shouldered cuts, another for work in non-ferrous metals and plastics. A single cutting blade, "one-spot" blade adjustment, the addition of a protective hand and eye guard, and light

weight are features of the tool. The bell guard directs flying chips downward. Only one blade setting is necessary and no separate adjustment of multiple cutters is required.

SHORT-RUN PARTS

*For Machinery, Made
Economically of Plastics*

LESS expensive than machined metal and more durable and dimensionally stable than wood, moldings of Laminac resin and fiberglass cloth have been used as label hoppers on packaging machinery. These hoppers have been a problem in precision labelling machinery, because of the complexity of shapes and sizes which must be handled by them quickly and accurately.

The problem was solved by molding hoppers from a low-pressure resin laminate, called Glastic, to produce small runs economically. The reinforced plastics parts have proved to be quite satisfactory, as far as strength, wearability, and appearance are concerned. The technique appears suited to use on printing and other production machinery where special parts are required in relatively small quantities.

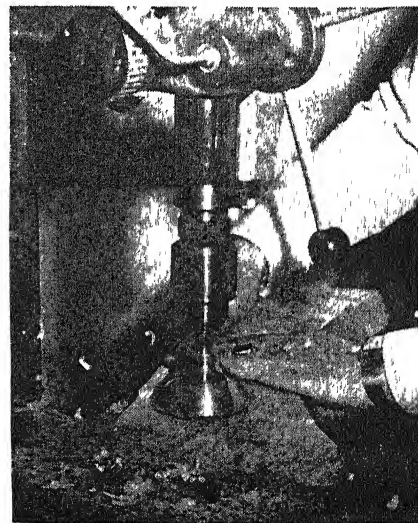
ELECTRICAL TACHOMETER

*Mounts Generator on Machine
and Meter in Remote Spot*

FOR PERMANENT installation where a "pick-up-unit" or generator must be mounted permanently on a machine, and the meter mounted on a panel far removed from the generator position, a new electrical tachometer employs a generator consisting of a small, permanent Alnico magnet motor mounted on precision-sealed ball bearings and capable of continuous operation at any speed within the limits of the meter.

The meter or indicating instrument is a rectifier type, including a sturdy D'Arsonval movement. It is capable of withstanding a momentary overload up to four times the maximum speed indication without damage.

For installation up to 200 feet the unit may be connected with two-conductor No 18 insulated wire. For longer distances, it is recommended that the manufacturer, Ideal Indus-



tries, Inc., be consulted for proper size of conductor.

The meters are rectangular in shape and available in either three- or seven-inch sizes. Both are available in three scale sizes—0-1250, 0-2500, and 0-5000 revolutions per minute

RAYON FABRICS

*Fade Less with
Anti-Fume Chemical*

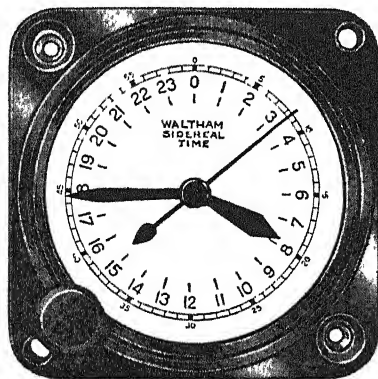
FASTER colors on acetate-rayon fabrics are made possible through development of Anti-Fume DE Paste, a new atmospheric gas-fading inhibitor. Certain dyes which previously faded when exposed to atmospheric gas fumes are given better fastness by the use of small quantities of this chemical material.

The Du Pont product is substantively absorbed by the fabric, and its protective effect persists after repeated washings and dry cleanings. It may be used with numerous popular shades on acetate rayon. This material is applied during the dyeing operation, and requires no additional equipment.

STAR TIME

*Told by New Watch
for Astronomical Use*

A SIDEREAL time watch, featuring an accurate 8-day movement and a 24-hour dial with a sweep-second hand, is now available at a lower cost than the usual



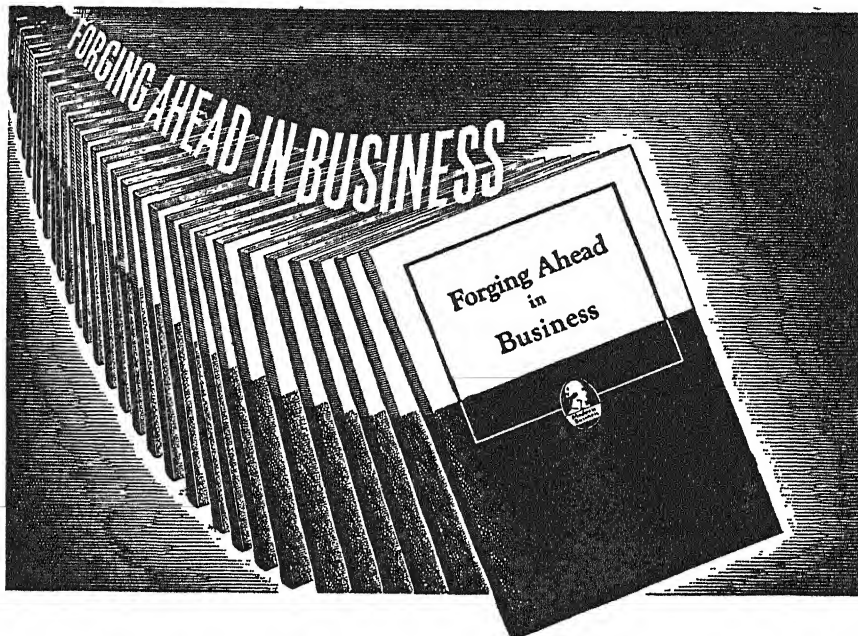
Astronomer's aid

astronomical watches. The Waltham sidereal time watch, when used with proper astronomical charts, tells at what instant celestial bodies are crossing the meridian. It is expected that the watch, said to be mathematically accurate, will be helpful to both amateur and professional astronomers.

PLASTICS-GLASS SHEETS

*Form Durable and
Decorative Lamp Shades*

UNUSUALLY attractive lamp shades with the appearance of antique parchment are now being made with a new kind of Fiberglas-plastics combination. Said to be highly practical as a decorative lamp shade material, the glass-plastics combination is impervious to heat and moisture and does not warp, wrinkle, or sag. Cleaning with soap and warm water is entirely possible. In fabrication,



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FORGING AHEAD IN BUSINESS contains a message of particular importance to production men. This is your opportunity to obtain a copy of this famous book, which has been described as a "turning point in the lives of literally thousands of men"!

Although "Forging Ahead in Business" has been distributed to more than 3,000,000 men, today's timely edition was written in the light of recent worldwide developments. Its 64 pages represent more than three decades of successful experience in training men for leadership in business and industry.

It demonstrates the method which the Alexander Hamilton Institute uses to give you immediate help in your present position, while preparing you for post-war opportunities. Subjects directly related to the work you are doing now, **PLUS** other subjects of fundamental value to the business executive, are discussed in the book and placed in significant relation to one another. Thus, a helpful, over-all picture is provided.

Said one man who had sent for "Forging Ahead in Business":

"In thirty minutes this little book gave me a clearer picture of my business future than I've ever had before."

... and that represents the opinion of

the Institute's 400,000 subscribers, including 134,000 production men!

The booklet further explains how it is possible to offer this essential training in a minimum of time; how the Institute program fits in with the most crowded of post-war schedules.

Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp., and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

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the material can be sewed, pleated, or glued.

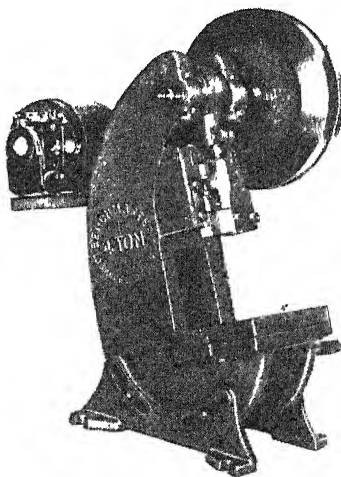
In addition to the antique-parchment type, the laminated sheet is also made in types resembling copper and gold—all with textures of decorative interest. These are adaptable to various light transmission requirements, ranging from translucent to opaque, and are equally pleasing to the eye with or without a light behind.

The basic sheeting, produced by Polyplastex, is also being adapted to use for decorative screens, wall panelling, and table mats, as well as display and packaging materials.

BENCH PRESS

Capable of Production
 Speeds on Variety of Jobs

UNUSUALLY compact, a four-ton bench punch press, designed to approximate the performance of larger presses, weighs only 215 pounds and operates at a speed of 285 revolutions per minute with a standard-speed electric motor. Features include a precision-ground shaft that is keyed by means of a press



Die space is 5 3/4 inches

fit to a large eccentric; over-size bronze bushings; and frames cast in one piece from semi-steel, heat-treated and heavily reinforced at stress points. A further feature of this press is an open back that makes it possible for work to be inserted from the front as well as from the sides.

When the ram is in up-position, a 5 3/4-inch die space is available. The six by eight-inch bolster plate has a thickness of one inch and has a two inch hole in its center.

The builder, Benchmaster Manufacturing Company, points out that although it was specifically designed as a punch press, this machine is also adapted to do stamping, marking, punching, crimping, riveting, and other high-speed production operations.

SILVER ALLOYS

Provide Low-Cost Joints
 In Two Temperature Ranges

TWO BRAZING alloys featuring lower silver content and called Easy-Flo 45 and Easy-Flo 35 have recently been

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

made available. The first-named alloy contains 45 percent silver, plus copper, zinc, and cadmium. One of its features is a low melting range—1120 to 1145 degrees, Fahrenheit. The joints produced between ferrous, nonferrous, and dissimilar metals are said to be strong, ductile, and leak-tight. The manufacturers, Handy and Harman, state that it offers the full advantages of alloys with a higher silver content but due to less silver in its composition provides an economy to help offset the recent increase in the price of silver.

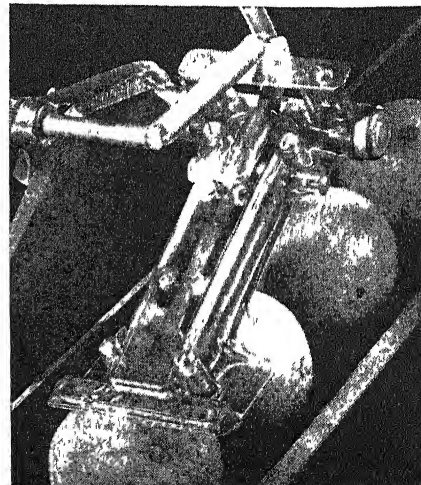
The 35 percent alloy has quite different characteristics, a wider melting range—1115 to 1295 degrees, Fahrenheit—and is free flowing at an exceptionally low temperature for an alloy containing 35 percent silver. It is intended for the economical production of joints between ferrous or nonferrous metals which are high in strength and ductility and is appropriate to use in places where its higher working temperature is not objectionable.

FRUIT COUNTER

Gains Accuracy with
 Non-Bruising Plastics Paddle

ELECTRICALLY-OPERATED citrus counters used in the highly organized citrus fruit industry are now equipped with "paddles" molded of transparent, tough Tenite plastics. The paddle is that part of the counter which the fruit touches as it travels down a moving belt. Electrical apparatus contained within the paddle records the number of pieces of fruit counted by the paddle.

Light weight and toughness are the two principal characteristics required of the material used in the paddle—the paddle not only must not bruise the



High-speed, non-bruising fruit counter uses light-weight plastics paddles

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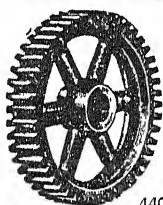
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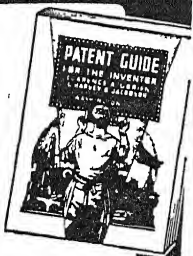
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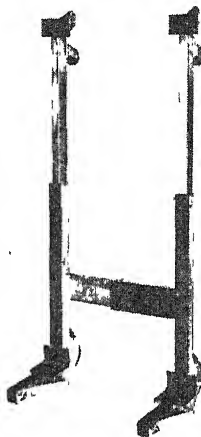
fruit which passes under it, but also it must not bounce after being struck by the fast-traveling fruit. This insures accurate counting and recording. The 2½-ounce Tenite paddle is reported to have stood up well under continual use.

Screw holes are drilled in the plastics so that the two parts of the paddle—housing and cover—may be fastened together. Electrical parts are tapped in during final assembly.

LOAD MOVER

Weights 27 Pounds,
Adjusts to Article Carried

CONSTRUCTED entirely of magnesium, a new light-weight two-wheel truck weighs 27 pounds as compared with its steel predecessor's 58 pounds. One of its features is the fact that it is adjustable in length from 41 to 58 inches, and in width from 19 to 29 inches, making it practical for handling stoves,



Magnesium parts reduce weight

refrigerators, and other items of varied size. Also, stairway hand holds are provided which fold under and snap out of the way when the mover is being used as a two-wheel truck and which are extended for use as hand grips when loads are carried up or down stairways.

The truck is equipped with rubber-cushioned main roller wheels. Two smaller wheels built into the main supporting members permit pivoting of the truck on landings and facilitate moving articles into recesses.

Made by Keen Manufacturing Corporation, the load movers were developed in co-operation with The Dow Chemical Company.

BATTERY WATER

Rarely Needed with
Extra-Capacity Case

A NEW automotive battery, which is said to have three times as great a water reserve as conventional batteries yet fits standard auto cradles, has recently been placed on the market. Built with a specially molded hard-rubber container one-quarter inch higher than ordinary units, the battery, called Sta-Ful, achieves its extra water capacity by increased interior space.

The extra space was obtained by

EVAPORATED metal films CORPORATION ITHACA

ANNOUNCING!

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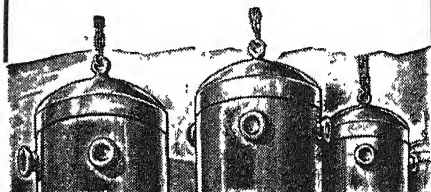
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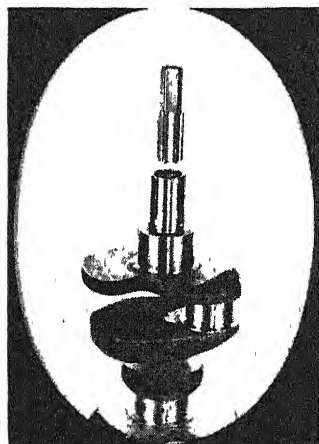
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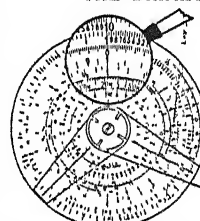
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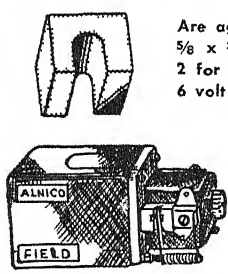
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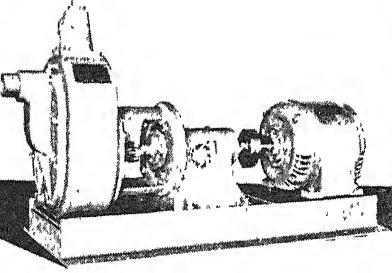
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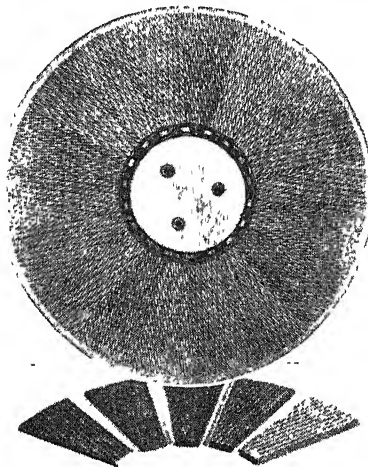
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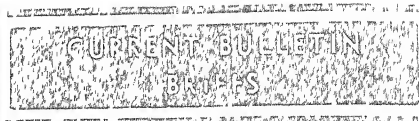
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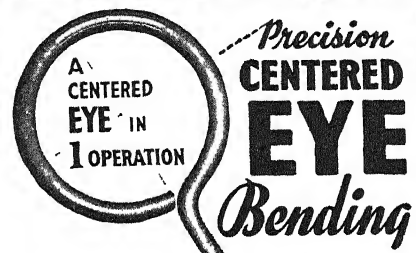


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The Editor

ics, physics, and mechanics. The book is intended to comprise about the right amount of material for an average college term, and treatment is predominantly mathematical. The examples, problems, questions, and solutions are essentially common to the college-text style and, as it must be, the subject matter is based on air properties, fluid and gas flow, airfoil behaviors, and general aerodynamic forces. Some discussion of compressibility effects, as well as a section on rotary-wing craft, is provided. (231 pages, 6 1/4 by 9 1/4 inches, numerous line cuts, graphs, visible-flow tunnel pictures, and tables.)—\$3 35 postpaid.—E.F.L.

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and A. P. Peck

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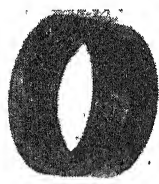
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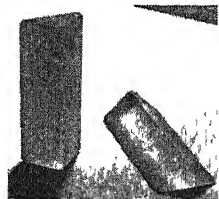
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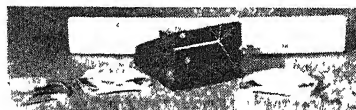
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ROSE TOOLS having petals which are tapered, in contradistinction to tools similarly used for local correction of optical surfaces but which are simply channeled in the normal manner, turn out to have been the invention of the famous "Uncle John" Brashear. Mirror makers have used such tools for years but their origin has been lost sight of Porter, in "ATM," 64, describes such a tool.

The rediscovery of the rose tool's origin happened thus. G. Dallas Hanna, a San Francisco advanced amateur, mentioned having come across "an interesting paper" in Volume 33 (1884) of the *Proceedings* of the American Association for the Advancement of Science, and when this paper was looked up it was found to contain evidence that Brashear invented that

scientists of the nation and did so in 1884, its title being "The Production of Optical Surfaces." This paper is not merely a historical curiosity; it lucidly presents instructions of as great practical application in 1946 as in 1884. The paper

It is the purpose of this paper to describe briefly a new method of producing accurate optical surfaces, both plane and curved. The hand and machine methods of past and present workers in this line of research should not be forgotten, especially Foucault's method of local correction and Dr. Draper's excellent modification thereof.

In order that the new method may be more clearly understood, attention is called to the serious difficulties met with in producing regular surfaces with the ordinary forms and methods of using local polishers. It is quite well known that the tendency of all local retouching is to leave on the surface of the abraded material what may be aptly called residual errors. This may be readily understood by the following illustration.

Suppose in the sectional view, Figure 1, we wish to work down the high zone, *a*, in an over-corrected surface. A local polisher is worked over the high zone, either by hand or machine, of a size corresponding with the breadth of the zone and usually circular in outline. The result of this local abrasion is seen in Figure 2 in which the zone, *a*, Figure 1, is seen to be broken down, but generally the residual zones, *b* and *c*, are left incompletely abraded by the edge of the local polisher, which must afterwards be abraded by a larger polisher, which may or may not introduce new periodic or systematic errors. Dr. Draper seems to have overcome this tendency in a great measure by the use of the machine described in his monograph. After many experiments and much careful study of these zonal errors, I endeavored to eliminate them with a machine constructed so as

to give an intricate motion to the polisher, a motion that would scarcely return into itself in many thousands of strokes. Notwithstanding the fact that this machine produced a number of excellent curves, it could not be depended upon, for in spite of the intricate interlacing of the polisher, zonal errors would creep in. After six years of labor I reluctantly gave up the pursuit in this direction. From the fact that occasionally good results were produced by the machine, I was led to a careful study of the forms of polishers, and after three years of experimental work, I have been led to this conclusion: that, given a properly shaped polisher, surfaces of the highest excellence may be produced, either by hand or machine work, and that the simple rotary and reciprocal motions are all that are necessary to be given to the polishing tool.

I will now give as briefly as possible the leading features of the method which I have found so sure and certain in its results, by which not only zonal errors are overcome, but by which any desired curve may be given to the optical surface under treatment. As it is necessary in all optical work to get the highest attainable polish, the first polishers are made in the ordinary form, i. e., with square or circular facets equally distributed over the surface of the tool, as shown in Figure 8. This is done to expedite the polishing. When the polish is brought up to the best (the best polish is no doubt the *finest scratching* we are able to do) the glass is allowed to come to a normal temperature, and is then studied by the admirable methods devised by M. Foucault for curved, and by Steinheil and Dr. C. S. Hastings for flat surfaces. Very seldom are the surfaces found free from defect. In order to clearly understand the method which I use for the correction of errors in producing a regular curve, let us take the former case of Figure 1, where the Foucault test shows a decided over-correction or hyperboloid of revolution on the concave surface. The zone *a* is to be depressed and at the same time new errors, especially zonal errors, are to be avoided. The iron tool, which is of the same diameter as the surface to be worked, is laid off into six points diametrically opposite with the dividers set to the radius of the tool; as in Figure 3. The tool is now warmed and the pitch is spread over the leaf-like spaces, which are given the proper curve by being pressed down on the (previously wetted) concave surface. The pitch and tool are now cooled quickly by an abundant flow of water. In the shaping of this leaflet lies the whole secret of success. The zone, *a*, Figure 1, needing the greatest amount of abrasion, the leaflet is made widest at that point, but in order that no zonal errors may be introduced, as in Figure 2, it is gently tapered in each direction, the amount of taper being somewhat governed by the amount of lateral stroke given to the polisher, as well as the amount of departure of the zone from the normal curve. After the proper shape is given to the correcting or figuring tool, the pitch is again

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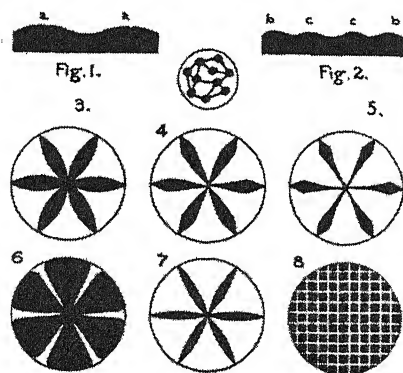
Crossroads on a famous career

type of tool. Background is supplied by Brashear's "Autobiography."

In 1872 Brashear, then a steel mill worker in Pittsburgh, started a 5" objective lens as an amateur, broke the crown lens while polishing it, started again and finished the telescope. In 1877 he started a 12" f/10 mirror, finished it but cracked it while silvering, but made another (At that time he found "Burton's Method" of silvering the backs of looking glasses described in *Scientific American*, modified it, and this was the genesis of the Brashear Method of fame.) In 1880, while still laboring in the steel mill, he inserted in *Scientific American*, October 30, the tiny advertisement here reproduced. "Alas for me!" he writes, "Hundreds of inquiries came to me from that advertisement;" such a market vacuum in telescopes existed at that time in this country.

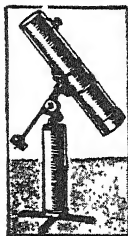
By Christmas Brashear had shipped three mirrors but, working daytimes in the steel mills, spare time on optics, he underwent a breakdown. The Pittsburgh philanthropist William Thaw saw him, liked the cut of his jib, gave him an equipped new shop, paid off his home mortgage, and told him to do optics whole time.

By 1884 Brashear "had invented and successfully used for several years a method of correcting the local errors in optical surfaces which proved to be very efficient" ("Autobiography") and which "has been used by many of the best opticians of the world. . ." He was invited to read a paper before the



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slightly warmed, pressed on the wetted surface, laid aside for an hour or so, and the work of correcting or figuring is then begun. When the polisher has worked long enough to transfer its own peculiarities to the surface under treatment, the glass is allowed to come to a normal temperature and again tested. If any change in the shape of the leaflets is needed, an inspection of the surface will indicate the character of the change required.

Cooper Key many years ago graduated the square facets of his polisher. Elliptical, ring and other forms of polishers have been tried from time to time with varying success, and I have myself tried many forms, but with none have I had such uniform success as with the form which I have just described. It has all the advantages of a local polisher without its defects, and as these leaflets can be so readily shaped, and so easily manipulated, we have a ready means of giving any desired form to the optical surface we are manipulating. Figures 4, 5 and 6 show the various forms of these polishers which are designed to correct different forms of errors. Figure 7 shows a polishing or figuring tool which will give fine results, when time is not an element in the work. Such a polisher would break down almost any form of irregular surface, and give a regular curve, the kind of curve—oblate spheroid, spherical, elliptical, paraboloid or hyperboloid, depending on the length of lateral motion given to the polisher; indeed almost any idiosyncrasy which a curve may present can be successfully treated with a slight modification of this form of polisher.

Flat surfaces may also be treated by modifications of the same general form of tool, and overworking the edge zone, so difficult to avoid in hand polishing, can be readily and easily overcome.

It is beyond the limits of this paper to discuss the various difficulties which the practical optician has to deal with besides those noted; but I would mention one thing that seems to be an insurmountable barrier to the production of an ideal optical surface, in the lack of homogeneity in material. It is a fact well known to everyone who has to deal with minute measurements that no two pieces of glass, speculum metal or other optical material made by artificial means are ever absolutely homogeneous when they come into the hands of the optician; hence every piece of material must have its special study, and in many cases idiosyncrasies present themselves which say "Thus far shalt thou come, but no farther."

If, in this brief paper, I have said anything that will add to the interest of this study, intimately associated with the names of Newton, Herschel, Ross, Lassell, Foucault, Nasmyth, Dr. Draper any many eminent opticians of to-day, I shall feel more than repaid for my work.

END of Brashear's paper. In it, he mentions the Draper modification of Foucault's method of local correction. This was described in Draper's paper "On the Construction of a Silvered Glass Telescope," 1864, in Volume 14

of the "Smithsonian Contributions to Knowledge." That paper was reprinted in the Smithsonian Contributions in 1905, Volume 34, as well as in Scientific American Supplement, July 29, August 5, 12, 1905. There Draper described his machine, the one shown in "A.T.M." 165, as a simplification of Lord Rosse's and Lord Rosse described that machine in 1840 in the *Philosophical Transactions* of the Royal Society of London.

There are a number of these old classical papers pertaining to telescopes. For example, Lassell on "Polishing the Specula of Reflecting Telescopes," *Philosophical Transactions* 1875, Ritchey on the "Two-foot Reflecting Telescopes of the Yerkes Observatory," in *The Astrophysical Journal*, 1901, and Ritchey "On the Modern Reflecting Telescope, and the Making and Testing of Optical Surfaces," from the "Smithsonian Contributions to Knowledge," 1905—all of which are out of print and to the average reader out of reach. Much of their content is obsolete and they are also too long to reprint in the present place. Some of them and others may, however, be reprinted in a sequel to "A.T.M." and "A.T.M.A." which has been planned, as sources of scattered pointers. It is difficult to estimate in advance how readers would regard these things. On the one hand, if you had the originals of these classics by your side would you read them? But if you had been asked to pay the added cost of including them in a book partly of original contributions, as in "A.T.M.A.," at about two cents a thousand words, would you then be critical? Please apply the same test to the inclusion of selected reprints—those of potential usefulness to telescope makers—from two decades of the present department and cast your vote.

Theoretically, all this matter may be looked up in large libraries but the difference between that and having the same things within the covers of a single volume, one's own, permanently available at home to pick up, dip into and throw down at any time, without strings attached, is almost absolute.

Your advice about this book is solicited and, as usual in human affairs, will be followed if it is liked.

CONTINUING last month's outburst of light verse, there now comes a contribution which presents a somewhat different and perhaps alarming after-complication of a severe case of addiction to telescopes. Jack Haviland ("A.T.M.A." chapter on designing and making refractors) has entitled his effusion "The Telescope."

When the shades of night have fallen
But the seeing's very bad
Other views may oft be had.
Sometimes a celestial maid
Has forgot to draw the shade.
Thus, from studies astronomical
One can turn to anatomical.

Albert H. Johns, Larchmont, N. Y., speaks feelingly in light verse:
The kitchen floor knee deep in pitch
To make a lap 'e'd 'ad an itch.
"I'll build a telescope," 'e said.
(When young, 'e'd fallen on 'is 'ead.)



INDUSTRIAL DRAMA. Jet-engine impeller blades are made of alloys truly "super" in heat resistance but so expensive as to be limited in possible applications. See also discussion of metal-economics, page 258. Photograph courtesy Westinghouse Electric Corporation

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Founded 1845

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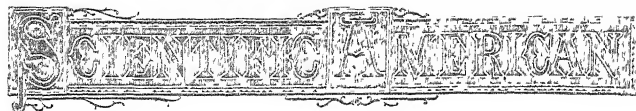
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50 Years Ago in . . .



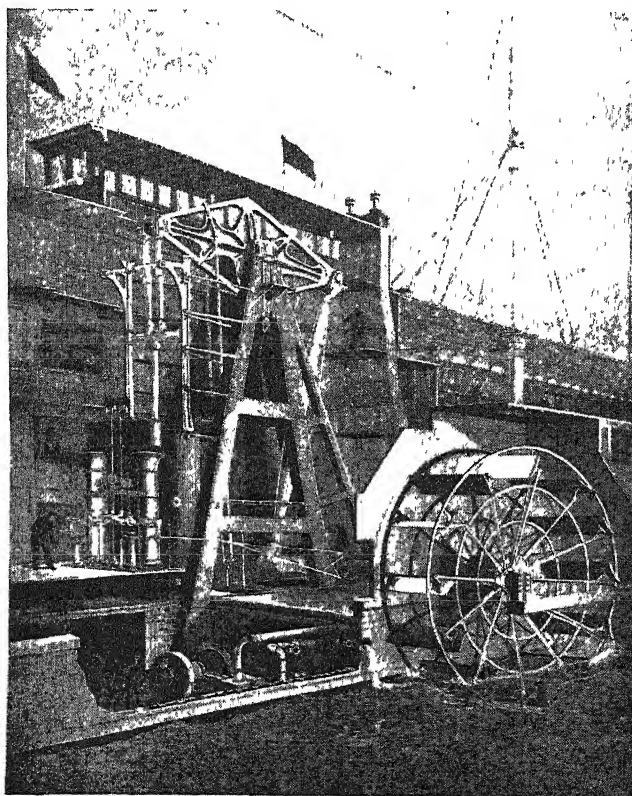
(Condensed from Issues of December, 1896)

AUTOMOBILES — "In saying that the advent of the horseless carriage, motor cycle, automobile car, or whatever it may eventually come to be named, is an event in the history of transportation second only in importance to the birth of the locomotive, the statement is made with the knowledge that it will have its special field of operation. It is certain that the perfected motor car will become a factor in the general scheme of transportation as essential in its way as the railroads themselves."

STORAGE BATTERIES — "In an electric lighting station the greatest demand for power is between the hours of six and seven P.M. and the next greatest between about the same hours in the morning. During the balance of the time the consumption is much lower, and after midnight it falls off to very nearly nothing. If steam engines alone are used, their capacity must be sufficient to meet the greatest demand, even if that only lasts for a few minutes, but, if storage batteries are added to the plant, these can be depended upon to take care of the excessive demands, and then the engine capacity can be considerably reduced."

ELECTRIFICATION — "The announcement that the New Haven Railroad is intending to make a further application of electricity to its steam roads will be taken as evidence that the present Nantasket electric line has given better results than the steam-equipped road. If this be the case, electric traction has taken another step in the direction of its application to the trunk roads of the country, and this goal for which electrical engineers are striving is brought within measurable distance."

RIVER STEAMER — "Latest addition to the famous fleet of Hudson River steamers that plies between this city and Albany, is the Adirondack. . . In order to give our readers a



clear conception of a typical river steamboat beam engine, we have prepared the detailed and very handsome engraving shown. The reader is supposed to be looking at the boat from a position a little off from the port bow, the side of the hull and superstructure and the housing of the paddle wheel being broken away so as to show the full height of the engine, which extends through four decks. The paddle wheels are of what is known as the vertical or feathering type, in which the buckets are made to enter and leave the water in a nearly perpendicular position. Steam is supplied by four steel boilers of the lobster return flue type. The steam pressure is 55 pounds to the square inch."

NIAGARA — "The first use of Niagara's power was made in 1725, a primitive sawmill being operated. Nothing more was done in this line until 1842, when Augustus Porter conceived the plan of hydraulic canals, and in 1861, one was completed. The Cataract Construction Company, from whose plant power has just been delivered in Buffalo, was incorporated in 1889."

RUST — "The iron and steel of modern construction are as perishable as they are strong. The action of the elements, which sometimes prolonged the endurance of an ancient structure, commences to destroy our modern works in iron and steel from the very first moment of contact. Unless some thorough system of protection be adopted, it is certain that the life of the skeleton steel buildings, for instance, which are multiplying so fast in our cities, will never be measured by centuries."

FLIGHT — "Prof S. P. Langley's invention, the aerodrome, again demonstrated, to the satisfaction of its inventor, its ability to fly, on December 12. . . The latest experiment was made on November 28, when the machine, launched from a specially constructed stage, flew 1,500 yards in a horizontal direction, and when its power was exhausted gracefully dropped, until it finally rested on the water."

100 Years Ago in . . .



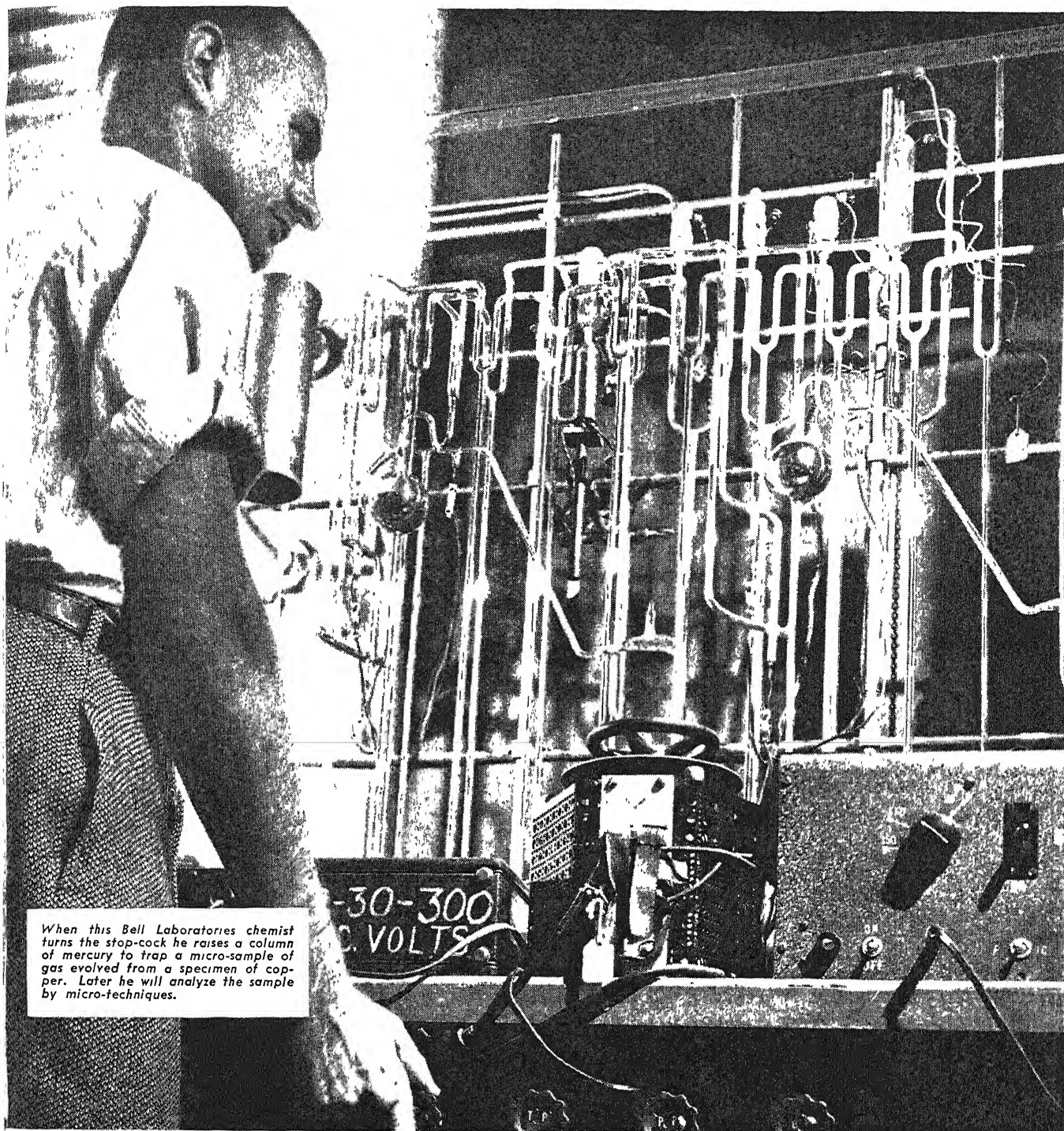
(Condensed from Issues of December, 1846)

LOCOMOTIVES — "Messrs Stephenson & Howe have introduced in England a new and powerful engine, the improvement of which consists in the application of three steam cylinders, two of which are of the same diameter and capacity, and both are equal in capacity to the third."

STEAMSHIP — "The New York ocean steamship now building at Westervelt and Mackay's ship yard, is intended as the first in the line of ocean steamships to run between New York and Bremen via Cowes, in the employment of the Post Office department. She is called the Washington, is of 1750 tons, custom house measurement, which is equal to about 2350 tons carpenter measurement."

GUNCOTTON — "The celebrated gunpowder manufacturers, Messrs. Dupont & Co., of Delaware, have succeeded in making explosive cotton of the best quality. These gentlemen are of the opinion that in the cases where cost is of secondary importance, it may be used to advantage; but in regard to its use in fire-arms it is too costly and dangerous."

PRINTING PRESS — "Messrs Dryden, the celebrated engineers, are now employed in the construction of a printing machine for the London Times, warranted to produce 12,000 impressions per hour, or the inconceivable number of 3 sheets per second!"



When this Bell Laboratories chemist turns the stop-cock he raises a column of mercury to trap a micro-sample of gas evolved from a specimen of copper. Later he will analyze the sample by micro-techniques.

Trapping poisons by micro-chemistry

A touch of a finger-tip—or even the dust in apparently clean air—can carry enough contamination to ruin an electron tube. Bell System scientists found this out through micro-gas analysis using new and original techniques.

They determined what could destroy the tube cathode's power to give off electrons, and how much—to the millionth of a gram. Then, with Western Electric, they developed manufacturing technique to keep these destroyers out of

the tubes. . . . Bell Telephone Laboratories scientists established the world's first industrial micro-chemical laboratory more than 16 years ago for the Bell System.

Today micro-chemistry is constantly at work, helping to raise still higher the standards of telephone service and performance.

BELL TELEPHONE LABORATORIES



EXPLORING, INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Previews of the Industrial Horizon

BIG BUSINESS NEEDS SMALL BUSINESS

IF THERE should be any thought that on the horizon looms the doom of small business, gobbled up and rendered extinct by the predatory animal which those of pinkish tinge delight to label "big business," give heed to some figures pertinent to the automotive industry. Here is big business if there ever was any, yet an automobile manufacturer, essentially, is simply an assembler. He depends for his very size on a group—an extremely large group—of suppliers for most of the parts which he puts together and markets under a well-known name.

One motor company has almost 3000 suppliers who furnish a vast variety of parts and materials which go into its cars; in addition, another 3000 suppliers furnish this same company with the goods and services necessary for the operation of its business. And at least 85 percent of these 6000 firms are "small business."

Then consider the Patent Office figures which show that from 65 to 75 percent of the functional parts of automobiles are invented outside the big laboratories and are produced by smaller manufacturers.

Big business pushing the little fellow out of the picture? Quite the contrary: Big business, with rare exceptions, leans on small producers, fosters them, enabling them to grow and multiply to the benefit of all.

LOOK TO THE SKIES

WHILE blimps can fly-out weather that grounds all airplanes, and have established a fine war-time record for dependability in service, there is still a question as to their commercial future. They are difficult to handle, require large ground crews and docking facilities, and are relatively slow. Yet there is one bright spot in their future: Aerial advertising. Thus MGM, movie producers, and Ford Motor Company have acquired two retired Navy blimps, equipped them with spectacular electric signs, and put them to work. Probably many more such aerial sign boards will dot the skies in the future, effectively carrying messages to the public. Here, at least, is one use for blimps; lessons learned in advertising may some day be translated into other lighter-than-air activities.

FROM THE FARM

SOYBEAN uses continue to grow and multiply. Expansion programs are underway, involving such varied products as candies, cheese, milk, fabrics, adhesives, cereals, synthetic resins, and surface coatings.

KING COTTON TOTTERS, SNAPS BACK

IT is an ill wind . . . and so on. Cotton is rapidly losing ground to rayon in tire cords, one of its most fertile fields. But now come three uses for the King of the South that promise to recoup much of the loss in tires.

By A. P. Peck

First is a chemically treated yarn rated at 70 percent stronger than regular yarn; second is an elastic cotton fabric made without rubber (see page 279, this issue); third is a textile resembling linen and with far higher absorbency and polishing characteristics than ordinary cotton fabric. This last material is composed of 80 percent cotton and 20 percent asbestos.

Cotton, at once the blessing and the black beast of the South, is yielding more and more of its potentialities to the searching eye of research.

SOUND ON WIRE

ALMOST 50 years old, the method of magnetically recording sound appears about ready to emerge as an important factor in the business and entertainment fields. Sound on wire, long hampered by technical difficulties, offers advantages of extremely high fidelity of reproduction, recordings of almost infinite length, ease of editing (in the case of metallized paper tape), permanency regardless of number of play-backs, freedom from record breakage, and small bulk of the record itself.

On the other side of the ledger, so far, is the problem of reproducing magnetic records in the quantities required to crack the popular market; overweighing this is the simplicity of recording business conferences, dictation, children's voices in the home, important radio broadcasts, and the like. Add the fact that the wire record, permanent though it is, may be instantly erased and re-used at will.

Old, yet still new, wide-spread use of magnetic sound recording now awaits only the solution of minor production problems and the availability of raw materials.

STRAWS IN THE WIND

DESPITE beginnings of the return of natural rubber to the market, the United States must maintain its synthetic-rubber production facilities as a safeguard in times of peace as well as of war. . . Buzz-bomb engines—pulsating jets—have possibilities in such things as blowerless industrial heaters. . . Millions of United States homes have no central heating plants, use space heaters; newly designed oil burners, quiet and clean, are aimed at this market, spell doom to pot-bellied stoves. . . Light-weight motor cars, efficient and convenient, will have tough sledding for many years to come, as in the past, largely because the American public, willy-nilly, wants to keep up with the Joneses. . . Two thirds of the wood cut from forests is wasted during manufacture and use; here is a challenge to engineers from the standpoint of conservation as well as of development possibilities.

INDUSTRY EMBRACES Weldments

Full Advantage Can be Taken of All Metal-Fabrication Methods and of Desirable Characteristics of Metals Themselves. Weldments Reduce the Need for Complicated Castings and Intricate Machining

IN ENGINEERING departments all over the country, draftsmen are attacking tough product-design problems and are coming up with weldments as the answers.

A weldment is any metal product which has been partially or completely assembled by welding. But when the engineer says "a weldment" he means a lot more than he used to mean when he merely said

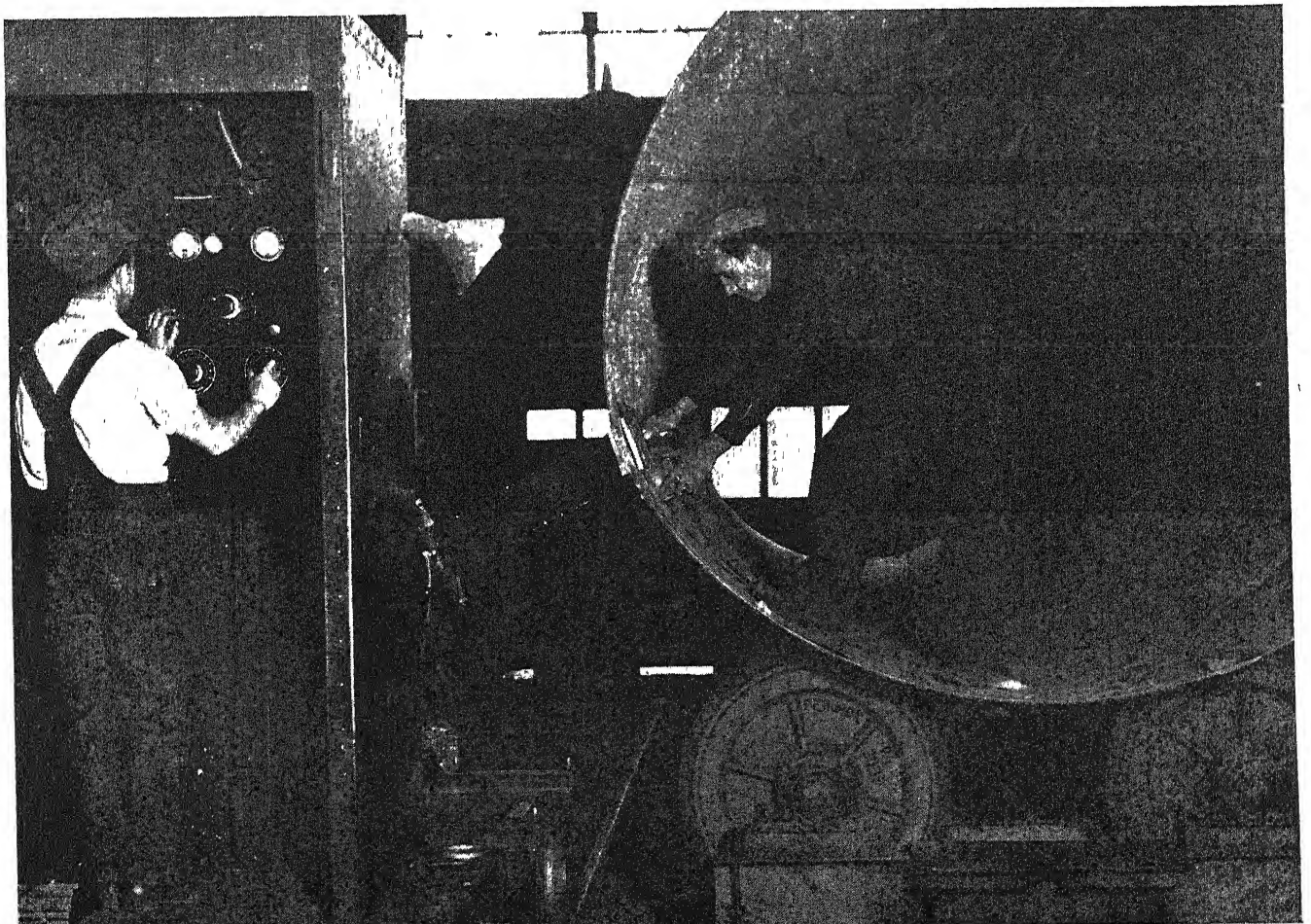
By EDWIN LAIRD CADY

"welding." Welding is a process of joining which, even in recent days, quite often was used only when nothing else would work. A weldment is a means of taking advantage of the highest abilities of every known metal-working method and

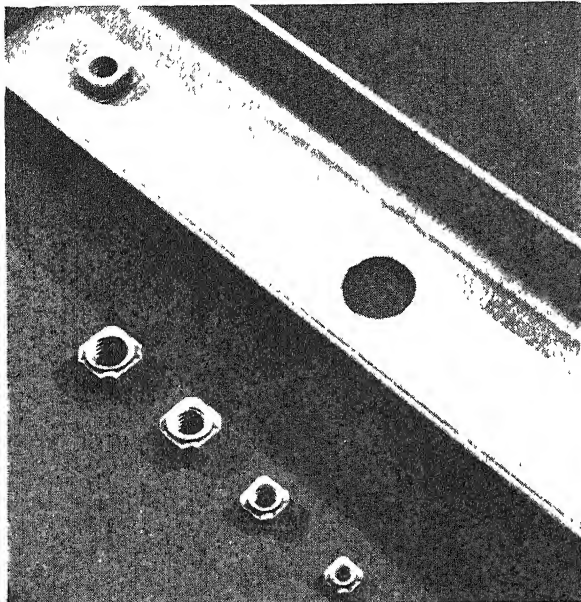
has now come to be used when plenty of other fabrication methods would work.

Back of the demand for more and more weldments is the constant struggle for better quality control in everything. More strength with less weight, more stiffness with less support, more resiliency with less bulk, higher or lower electrical conductivity, greater safety, less cost—in every metal product he designs, the engineer finds a demand for more and more ability to do the intended job.

The engineer can get some good points out of every fabrication method—casting, rolling, machining, extruding, forging, and the rest. But with every process he has two problems. He may need the best of two or more completely different processes in the same finished piece. Or he may need something that an in-



Courtesy The International Nickel Company, Inc.
Inspecting nickel-clad steel weldment. X-ray machine moves along tracks, the weldment rotates on its supporting rollers



Projection welding of special nut to angle flange is a practical solution to the need for a substantial threaded hole in thin metal. This is just one example of potentials of weldments.

dividual process can give him only at a prohibitive cost.

It is when he meets these two problems that the engineer can resort to weldments.

VARIETY IN CASTINGS—Compromises taken out of the design of castings is an example of what can be done with weldments. Quite often the engineer needs a part of such size and shape that it ought to be cast in the foundry. But in one thick area he may need very hard metal; in another, soft and machinable metal; in a third, high resistance to corrosion, and in a fourth, contours of such intricate shapes that they are hard to produce by casting.

Before the techniques of design-

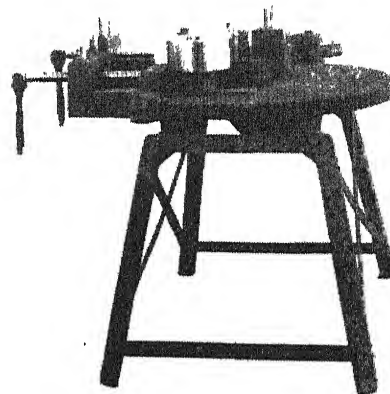
ing and making weldments became so well known, the engineer would have had to sacrifice some hardness in the hard area to make the soft one machinable, some intricacy of contours to be able to cast corrosion-resistant metal, and so on. Now he casts four different pieces, each of which has the properties desired for its area of the final product, and welds them all together into the finished piece. He even may do his machining on these pieces before he does the welding, and so substitute the lower cost of handling small pieces in his machine tools for the higher cost of handling a single large and heavy one, with all of its attendant difficulties.

Many of the gains from weldments come from the joining of somewhat

Stronger, less costly metal products.
... Fewer compromises in design.
Simplification of forging operations through use of smaller parts, later to be joined by welding.
... Increased use of weldments opens to engineering possibilities now more fully understood.

dissimilar metals. A large casting has to have long arms or bosses which are used as shafts for the bearings of gears or pulleys. Formerly these extensions were parts of the casting itself. They were difficult to cast, if one were spoiled in the machining, then the whole bulky casting had to be discarded. And machining such areas on a large and heavy casting was by no means easy.

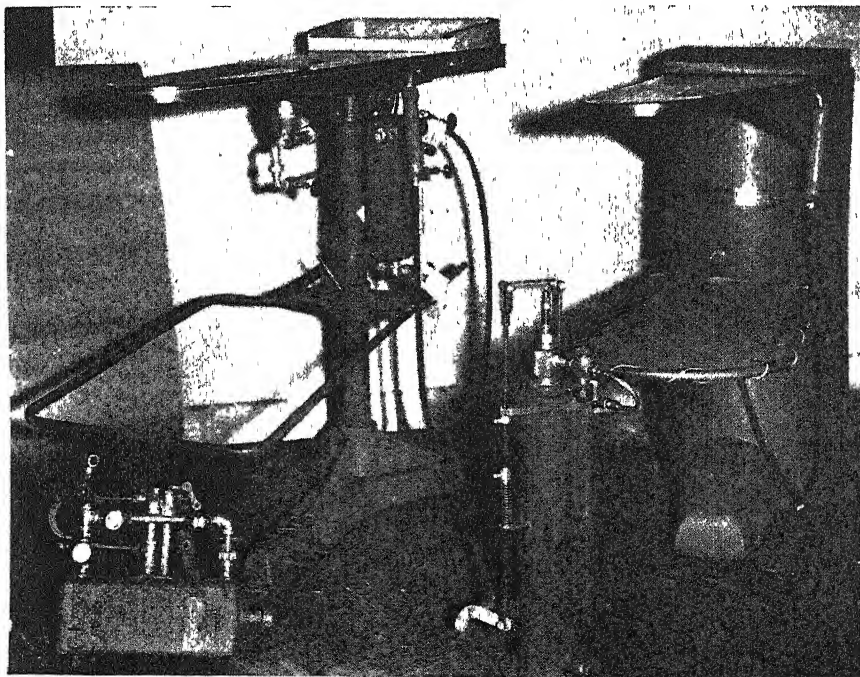
Now the casting is made without these arms. Simple pieces of cold-rolled steel are welded on. The cold-rolled steel needs no machining and is a much better bearing support than the cast iron could be. The



weldment costs far less to make, entails no risk of spoiling huge castings, and is a better product for its service.

Many large castings must be machined on several surfaces, all of which must be in close dimensional relationship to each other. There used to be a difficult problem in knowing just how to take hold of such a piece in the chuck of a lathe or on the bed of a planer so as to machine off a true control surface from which all other surfaces might be machined true and parallel. Very often the casting had to be machined on several different machines and to be mounted differently on each with many resultant opportunities for errors in the relationships of various surfaces to each other.

Now a true and round piece of steel is welded to the most con-



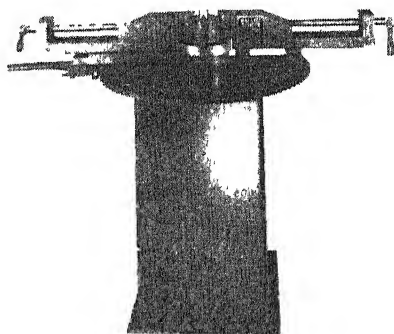
Courtesy Lincoln Electric Company

All-welded spotting machine (right) compares with older design (left). The greater freedom available to the designer of weldment construction is clear.

venient area of the casting. On a large gear casting, for example, this area would be the hub

Casting and steel piece thus become a weldment. The weldment is chucked by the steel piece which acts as a known and true control surface. If the machine tools are true and accurate, then every dimension machined from that control surface must come true and accurate to it and all dimensions will be true to each other.

LOWER MACHINING COST—The finished piece is much more accurate than was formerly the case. And since such a control area lends itself to chucking in the simplest of turret lathes and other machine tools, the machining costs are less.



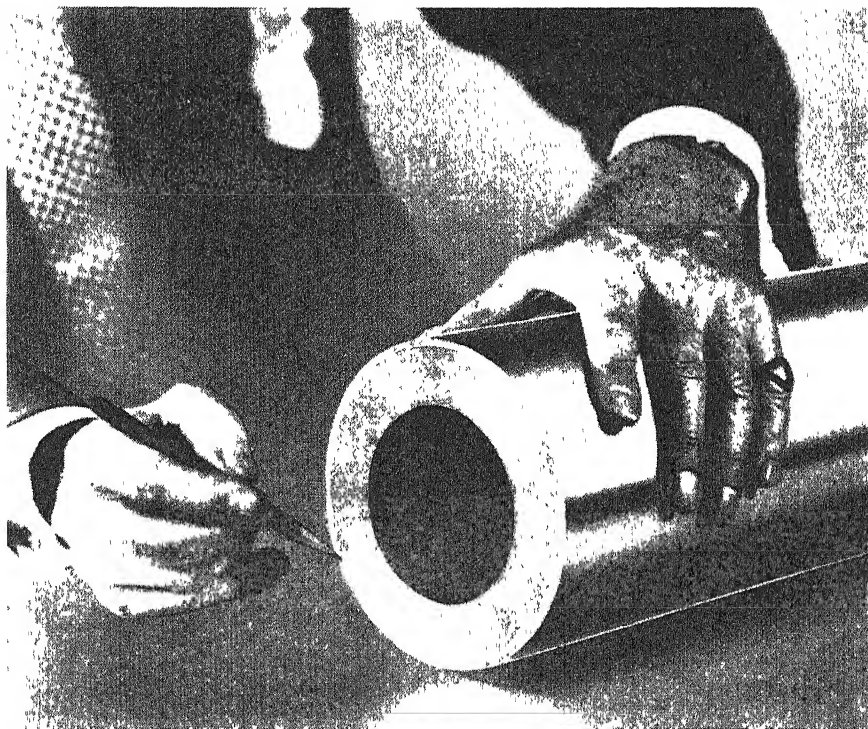
Cast bending-rack parts for machine on opposite page cost \$60; assembled unit weighed 1260 pounds and required two men to operate it. Welded unit as seen above weighs 736 pounds; needs only one operator; and same parts, now weldments, cost only \$32

The piece of steel which had been welded on may be cut off immediately after completion of the machining operations, or may be left in place as a holding area for cranes and other materials-handling equipment to grasp until the piece has finally been assembled into the finished machine.

Modern welds can be machined, bent, stretched, forged, subjected to any operations which the parent metals can stand. They can be heat treated, quenched, tempered, case hardened. They can be plated, painted, or otherwise finished.

From these abilities come other extensive uses of weldments

A large, deep shell with intricate curvature on its outside diameter has to be provided with a strong threaded holding area at its bore. Former production methods called for rolling and stamping the whole piece as a unit. In order to get the necessary strength at the bore area the whole piece had to be made of a



Weldments allow metals to be combined to use their best features efficiently. Here, welded-on nickel alloy will increase the life of this paper machine roller

material which is very difficult to fabricate. The piece had to be pressed and drawn a little, then annealed to soften it and remove the work-hardening which forbade further pressing, then drawn a little farther and annealed again, several times. Often it would weaken or would flow incorrectly and have to be discarded after a great deal of costly work had been done on it. And when all other operations were finished the upper edge had to be flanged over by rolling or spinning, and the bore machined.

Now a far stronger and less costly weldment, made of three sections, does the same job. Two sections

comprise the main body and a third the bore or hub. The sections of the main body are stamped into semi-circular pieces of the desired finished contours, including the cross curving and the flanging, but with one edge straight. This is a simple deep-stamping operation.

The second operation is to weld these two pieces together into a complete circular weldment. Next, the straight edge of this weldment is pressed and spun over so that it is at true right angles with the outside diameter and the whole weldment resembles a curved-edge round pan with a large round hole left in the center of its bottom. This spin-

Courtesy Westinghouse Electric Corporation



Welding the vanes of this blower results in assembly-time savings. In addition, warpage is less, balance and uniformity better. Closer quality control is one factor responsible for the swing to weldments

ning and pressing can be done because the metal is of a kind quite different from the tough alloy which formerly was worked (it is a metal which flows easily under the dies) and because the welds will stretch and flow at exactly the same rate as does the parent metal.

Only the hub or bore is made of the tougher alloy originally used. And this piece is a forging, much stronger than it formerly had been.

The final operation is welding the hub in place. Net result is a better product, made at lower cost.

DIRECTIONAL STRENGTH—When considering fabrication methods for highly stressed parts, designers have long been in the habit of giving the nod to forging. And when they did, the costs usually went up.

Now, forgings are broken down into the areas easiest to work under the hammers, then welded together. This method cuts thousands of dollars from die costs, eliminates rejecting of large forgings for faults occurring only in small areas. Even more, it permits taking more advantage of that prime asset of forging, control of directional strength.

Directional strength means that metals can have grains somewhat similar to the grains of wood, although not so pronounced. Whenever metals are rolled, drawn, stamped, spun, or otherwise "worked," these grains appear and run in the directions in which the metals have been caused to flow. The metals are stronger in the directions of their grains, weaker across the grains.

Weldments can be so assembled that grain strengths run in the directions in which strengths are most needed, very much as wood structures are so designed that most of the heavy loads run "with the grain." In forgings and in stampings, or other "cold forgings," the grains can be caused to follow curved paths, but not always to exactly the curvatures desired. When the engineer creates several smaller parts having the desired grain directions, and then welds these parts together in such fashion that the grain strengths support and reinforce each other, he creates a finished piece which has all the strength that grain can give it.

Grain in metals has other effects. Electrical currents like to go with the grain. Parts which must roll or slide upon each other will have longer endurance if the direction of wear is with the grain.

It is practical to take simple flat sheets of metal, roll them into cylindrical or other shapes, weld them where the ends meet, and so

have finished forms for electrical equipment in which the grain is in exactly the direction in which it is desired to have the current flow.

Machine beds, slides, races for ball and roller bearings, clutch parts, brake parts, and plenty of others, can be so designed that weldments provide grains in the directions of greatest friction and abrasion. Work-hardening in service, which often is depended upon for prolonging the lives of such parts, can be most successful when the working is parallel to the previous work-hardening that provided the grain structure. And lubrication of the part also may be helped.

DESIGNS SIMPLIFIED—Weldments simplify designs in which heavy stresses are imposed over limited

areas. Reinforcing pieces can be welded to such products so that they absorb some of the stresses and pass others along to the primary structure. When this is done, parts can be made lighter and stronger and can be more trustworthy for the same loadings. Designs of these kinds appear in airplanes, automobiles, railway equipment, almost everywhere that great strength and shock resistance with light weight is needed.

Engineers have hardly scratched the surface of the field for weldment designs. The greater the pressure to design better and stronger machines, the more will weldments be used. Weldments are the team players in the field of design, the elements which help all other fabrication means to be at their best.

FIBERGLAS USE

Expands Where Heat and Chemical Resistance Is Needed

THE ABILITY to withstand both heat and the action of some chemicals is making Fiberglas an industrial servant of many uses.

Electric motors which have given trouble in the field may be re-



Glass cords resist dipping solutions

wound with it. One such motor, which had failed several times in the field, was re-wound with Fiberglas insulation in 1939 and has operated without failure ever since.

Another up-and-coming use of Fiberglas is in the form of cords for dipping machine parts in protective solutions and afterwards for hanging the parts to dry.

IN-PLANT TELETYPE

Adds Flexibility to Complex Production Operations

THE CLASSIC difference between the large shop and the small one is that of flexibility. The large shop is inflexible, and once a production lot is moving through it, schedules and

procedures are hard to change. The small shop can change easily.

In an effort to achieve more flexibility, many large plants are now using the teletype. With this, typed messages and forms can be sent quickly to any one department or to several departments simultaneously. Department supervisors can be warned of the receipt of goods which mean step-ups in production rates in their departments, whole manufacturing sections can be ordered to change outputs or prepare for other changes.

Such a system cuts down materially on the delays which occur when the shop telephone and the shop mail system alone are in use.

TENSILE TESTERS

Brought to Production Line for Rapid, Practical Use

WHEN an engineer is handling a familiar machine part, or when it is desired to know the true strength values of materials which have been fabricated into bar stocks or other common shapes, then tensile tests and hardness tests are the measurements which usually can reveal the most in the least time. Dozens of interpretations can be made from these two tests, and portable hardness testers capable of making hundreds of tests a day are an old story. Now, the use of portable tensile-strength testers capable of equally fast operation is growing. These machines do not have the complete adaptability of the portable hardness tester. But they are taking one more "laboratory-type" test out of the inspection room and transferring it to the production line where it has its highest value.

High Pressure Plastics

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

THAT THE great versatility of plastics in general and the wide range of end uses to which they are put has brought forth a proportionately diversified number of production methods is a fact well recognized by most persons interested in the industry. As is frequently the case in other fields, the latest process to be developed tends to eclipse older and often equally useful or better processes. So it has been with plastics laminates. Thus, low-pressure molding (see "Molding Unlimited," *Scientific American*, June 1946) has received a substantial impetus during recent years and as a result there is a danger that the full possibilities of high-pressure laminating, developed over the past three decades and still achieving new uses, will be overlooked.

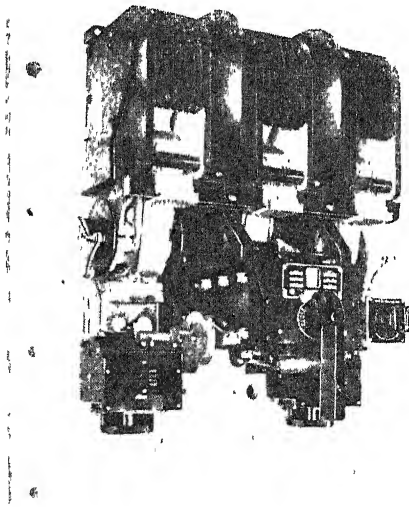
High-pressure laminating, admittedly, requires molds, presses, and so on, that must be constructed to handle the pressures involved and hence are often relatively expensive. On the other hand, high-pressure laminates can be produced that have remarkable resistance to moisture, wear, and chemicals. Their record is good and, judging by the tentative plans of some industries, neither the decorative nor the industrial high-pressure laminates have yielded to any other materials one iota of their pre-war markets and new markets are coming more than half way to meet them.

HUGE MARKET—In view of the serious problems now facing the building industry in obtaining materials for new construction and for the renovation and redecorating of old structures and places of business, it is well to inquire first as to the place of high-pressure laminates in this work.

The National Housing Administration proposes to erect two million

new homes during the next year. Into these will go high-pressure laminates as wall decorations, as parts of bedroom furniture, as bathroom wall surfacing, and as accessories. The kitchens of these homes, and the kitchens of the nine million presently constructed homes which equipment people expect to be called upon to re-equip, will find good use for these materials as kitchen sink work tops and as kitchen or dinette table tops.

Hotels, restaurants, bars, barber shops, offices, all types of more or less public rooms, in fact, are even more fertile fields for high-pressure



Courtesy Continental Diamond Fibre Company and I-T-E Circuit Breaker Company

Good electrical qualities make high-pressure laminates ideal for articles like the circuit breaker shown above

laminates. The reason lies in the explanation given by the purchasing agent of a hotel chain for his installation of several thousand laminated window sills. Prior to purchase he had subjected the material to repeated kicks, butted cigarettes against it, poured liquor over it and, when finished, had carelessly wiped the surface with a damp cloth, only to find a still satisfactory surface on the sample. As unreasonable as tests of this type are, these laminates have been meeting them and, in so doing, have been marking off for themselves a big share of the hotel,

• LOOKING AHEAD •

Extensive use of high-pressure laminates in public and private housing. . . . Decorative effects as yet only hinted at. . . . Lower costs with newly developed core materials. . . . Many applications in sudden-stop-quick-start machinery. . . . New laminates adapted to compound curves.

restaurant, and automobile markets.

In the hotel field alone there is a tremendous immediate market. The American Hotel Association estimates that 1½ billion dollars will be required to rehabilitate, modernize, and build additions to existing hotel structures. This involves almost 13,000 hotels with over two million rooms. On furniture tops and window sills, the average hotel room would use about 24 square feet of decorative laminate. Thus, if only 10 percent of the existing two million hotel rooms are so equipped, there is an immediate market for 4,800,000 square feet of laminate. In addition, American hotels are in immediate need of a half million dollar's worth of serving trays, many of which can be high-pressure laminates; 116 million dollars worth of cocktail lounge and bar equipment; a million dollars worth of elevators, in all of which the decorative laminates will share to a considerable extent as table and bar tops, as trim, as bar front paneling, and as elevator interior walling.

DECORATIVE LAMINATES — For the most part these decorative laminates will be 1/16-inch sheets made of 11 layers of paper, the nine layers in the core being impregnated with phenolic resin and the two outside decorative sheets being impregnated with melamine. Urea is still widely used in the translucent laminates.

The high-pressure laminates are, of course, going to meet with competition from other materials in the decorative field. In table tops, for example, they will compete with enameled steel, with glass, and with wood. Enameled steel tends to chip, stain, and warp under too much heat; glass has a tendency to chip



Courtesy Calplast Corporation and Formica Insulation Company
Attractiveness and long life of pressure-laminated plastics are responsible for their continued popularity. Kitchen work surfaces (above) and areas that receive hard wear in taxicabs (right) are typical usages of these materials

and shatter and is cold to the touch; wood dents and stains and costs quite a bit to maintain.

In kitchen work surfaces, high-pressure laminates face competition from linoleum which must be strongly supported, pits, and does not have the same chemical resistance as the laminates. Other contenders for this market are tile, which will not stand up to too much vibration and impact, stainless steel, which is expensive and subject to stain under some circumstances; and enameled metal, which cannot take the same punishment as can the laminates.

The competition from other materials should not be so great in equipment for bars, restaurants, and hotel furnishings. In these applications ease of maintenance is an important factor.

As for the costs, it has been found that, given equal chemical and physical qualities, all table and kitchen work surface top materials have about the same final cost, with linoleum having a slight advantage. Wood, however, when treated to make it resistant to acids, alkalis, heat, and so on, becomes expensive. In general, flat high-pressure laminates without edging cost about \$1.25 a square foot, with plywood or other core material included.

CORE MATERIALS—The cost of the core material used as the base for many decorative high-pressure laminate applications, and its availability, will continue to have a considerable influence on markets. Plywood, long the standard core and the most economical to date, currently is not readily available—a situation that is likely to continue

for some time. At present, fabric honeycomb for cores is rather expensive—a dollar a square foot.

There are a number of honeycomb structures presently under development which, it is hoped, will resolve this price question. One is a new paper honeycomb whose possibilities seem clear considering that paper costs seven cents a pound against a fabric cost of about 65 cents. And there is at least one laminator who proposes to ply a laminate to 1/32-inch tempered pressed wood at about 60 cents a square foot for the total job. In Canada a paper mill is going ahead with a lignin board program to provide core material for table tops. Another company is experimenting with a self-supporting decorative laminate.

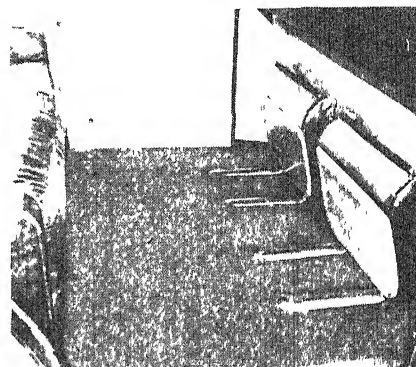
It is doubtful that high-pressure laminates will have wide use in the wall decoration field. The contact-pressure laminates, the vinyl wall-covering materials, metal, wood, fabric, and linoleum will all be offering competition. And new competition is coming up. There is, for example, striated plywood, a three-ply sheet 5/16 inch thick, bonded for internal grade with urea to sell at 13 cents a square foot and bonded for exterior grade with phenolic to sell at 20 cents a square foot. Another material consists of a thin sheet of aluminum bonded to a thin ply of textured wood—the material being applied to walls with the metal on the underside. The latter costs about 35 cents a square foot which is substantially cheaper than standard 1/16-inch decorative laminate.

The new papers which are being developed for surfacing plywood right on the press are yet another

source of competition for high-pressure laminates in wall applications. Some of these resin-impregnated papers can be applied to ply for as little as three cents a square foot.

USEFUL INDUSTRIALLY — High-pressure laminates will, to all appearances, continue to serve the industries where they built their original reputations. These fields include the electrical and the related communications industries, textile manufacturing, aviation, automotive, and the maritime industry.

The old standbys in the electrical industry are the paper- and fabric-filled phenolic laminates. The war brought the glass-fabric bonded



Courtesy American Cyanamid Company

with melamine resin laminates which provided high strength, high arc resistance even when wet, and heat resistance. As for the silicone-glass laminates which are now undergoing tests, it is questionable how much the present very high prices can be reduced. Another new product is an asbestos-melamine laminate designed to give very good combined arc and heat resistance in the presence of moisture.

In the textile industry a rough estimate indicates that there are at least 18 uses for high-pressure laminates. Among these items are picker sticks, bobbins, doctor blades, carrier rolls, and loom-box linings. Research, however, is intensive in this line and the list of applications should take a spurt. The high-pressure laminates' chief advantage in this field lies in their ability to overcome the problem of static generated by friction in all textile processes.

These laminates are well adapted to jigs, fixtures, and forming tools in the aircraft industry. Here, their comparatively light weight—half that of aluminum and one fifth that of steel—means a reduced outlay for such equipment. Another important factor which accounts for the standardization of laminates as the material for pulleys, axles, ball-bearing retainers, bearings, cams, and other items is the strength-weight ratio of these materials. This factor is

growing in importance because modern machinery must travel at very high speeds, yet must be able to start and stop frequently and easily.

The factors that account for the use of high-pressure laminates in the electrical, textile, and mechanical fields are also all important to the automotive manufacturer. A typical and promising application in this industry is the use of the laminates as inside paneling and as the kick-plates of jump seats in taxis.

In the marine industry an interesting use of a cotton-fabric laminate is found in the marine-bearing housings of stern-tube shafts for underwater use. Success here has led to the manufacture of bearings for similar application in other industries—steel rolling mills, to give one example.

WHAT'S COMING UP—There are many developments being worked upon that promise interesting things in high-pressure laminates. A few

such items include papers such as Patapreg, developed by the Forest Products Laboratories, which are formable in compound curves, and knit fabrics for the same purpose. There are laminates with nylon-fabric filler and melamine or phenolic resins which are applicable to electrical, communication, and radar work.

There are a dozen new laminating resins, and combinations of glass, fabric, paper, fiber, rubber, wood, and other materials in single sheets, rods, and tubes of laminates designed either to improve the qualities of the product or bring down the costs, or both. Also new is engraving stock, white inside and black outside, for use in instrument faces, dials, instruction signs, and so on.

Currently, many new products are in the development stage, some ready for the market. What is missing is enough material—paper, fabric, resin, core material—the same complaint of almost every industry today.

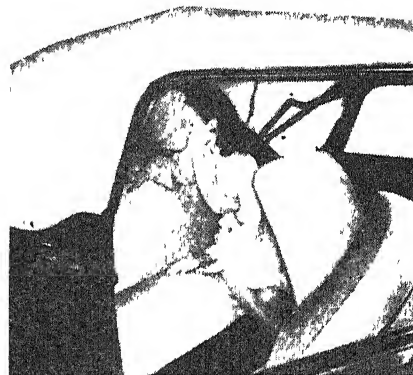
was found to have the added advantage of being pleasing to the eye.

Other plastics applications in this renovated railroad coach are molded acrylic lighting shields and plastics display cases and curtains. The plastics used are a product of Bakelite, Ltd. of Great Britain.

PLASTICS FABRICS

*Meet Needs of
Automotive Use*

UPHOLSTERY, in convertibles and station wagons, is expected to afford a very practical application for the new synthetic fabrics. Appearance, durability, and resistance to dirt and



Seat material resists wear and stains

stain is of paramount importance in these coverings and the plastics fabrics are said to fill the bill. One such fabric is Duran, a film made from Geon by Masland Durableather Company.

COLORFUL LAMINATE

*Combines Features of
Two Plastics in One*

FOR industries requiring a material with the optical and light transmission qualities of acrylic and the vigorous color characteristics of nitrocellulose, there has been developed a new laminate called Kolor-Plex. Celluloid sheets in iridescent pearl tones, in "bread pudding" effects, and in translucent colors are laminated to thicker sheets of Plexiglas and delivered to fabricators who use the laminates in making powder boxes, cigarette cases, hand-mirror backs, bathroom accessories, and a wide range of other items.

The makers of this laminate, Willson Plastics Division, Willson Magazine Camera Company, state that exhaustive tests indicate that the adhesion is sufficiently strong for all purposes to which the material would be put, and that in fabrication, tools normally used on the acrylics are quite satisfactory for this new material as well.

RAILCOACH REJUVENATED

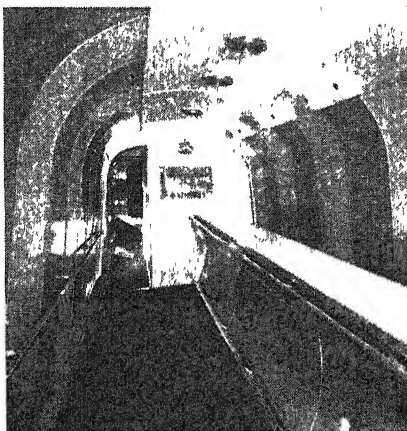
*With Plastics Panels
in Modern Colors*

THE ancient railcars which were thrown back into service during the war because of the extra heavy traffic and the inability of railroads to get more than a trickle of new cars, may have yet another lease on life. In England, an outmoded, plush-seated, dark-panelled coach has been modernized by the use of plastics laminates and a variety of molded plastics parts.

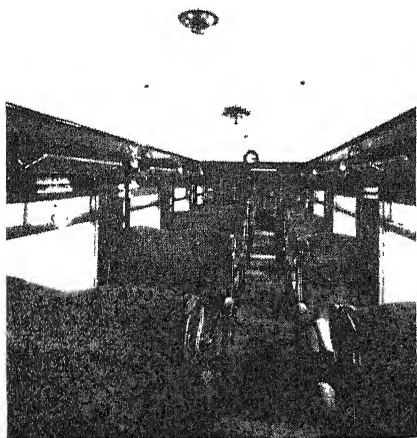
In redesigning the old coach, everything was removed, down to the outer shell. Then a wooden framework was built which outlined the old walls and acted as a support for the laminated panels selected for the walls of the new car. Not only the walls, but the bar and table tops as well are surfaced with Waireite laminated in a color

scheme of pink, grey, and cream. The laminated plastics, used in 5/32 inch thickness, weighs less than half as much as aluminum and has a high impact value. Equally important is its resistance to hard and careless treatment such as the spilling of hot liquids, juices, and alcohol.

The walls, which follow a continuous swooping curve from floor to ceiling, comprise alternate panels of pink and grey, a color scheme that is echoed in the upholstery material. The same asbestos fabric that covers the chairs, stools, and wall benches is used to surface the wall laminate. Balancing the curve of the walls is the contour of the bar front which has a reverse curve. This was done to insure ample leg room for standing passengers, but



Interior of old railcoach (left) was stripped out and panels of plastics laminate installed. Result (above) is a surprisingly modernized appearance

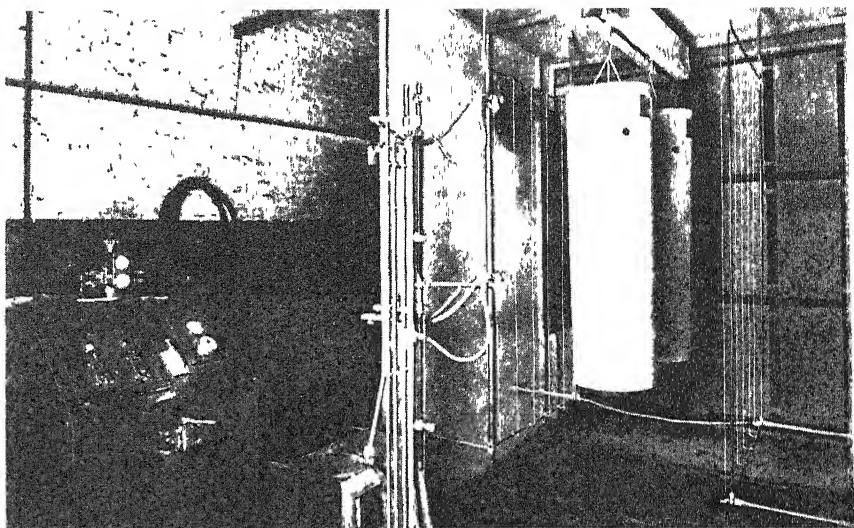


By VIN ZELUFF
Associate Editor, *Electronics*

A SHORT time ago a boiler manufacturer was employing three men to hand-spray one coat of synthetic baking enamel on water-heater casings. One gallon of enamel covered 10 to 15 casings. Today that same manufacturer is covering twice that number of casings with one gallon of the same enamel. But now the operation is automatic to the point of requiring only one man to check and set the controls of the equipment. And the finish is more consistently uniform.

The answer to the "enamel stretching" process described above is packed into one word—electrostatics. A glass rod charged with static electricity by rubbing it with a silk cloth will attract or repel small particles of paper or lint, depending on the polarity of their charges. Similarly, charges of commercial magnitude, generated and controlled by electronic equipment, are being used in industry far and near to do a multitude of jobs. In the example cited above, the casings and the paint bore opposite charges. Hence, the particles of paint leaving the spray gun were snatched from the air to the casing instead of drifting hit or miss in the general direction of the painting surface. Essentially, the paint was drawn to the casings like paper particles to the charged glass rod, and overspray waste was reduced to a minimum.

Another example: In a conventional automatic-spraying set-up for painting the outside of metal wastebaskets, each basket was inverted over a perpendicular holder. This rotated the basket as the conveyor moved it along through a booth in which three stationary spray guns forced the paint directly onto the containers. Now, with electrostatic spraying, the same equipment and the same materials are used. But the difference is that within the spray booth are arranged suitable metal electrodes which, when charged from a special high-voltage electronic power-pack, produce an electrostatic field within and around the spray painting zone. The number of guns is reduced to two and these are directed approximately parallel to the conveyors so as to atomize their material into the electrical field. For electrostatic spraying, the spray guns are adjusted to atomize



Paint particles, sprayed towards water-heater casings, are directed to their target by a static field created by the electrically-charged vertical rods

ELECTROSTATIC Painting

Overspray Waste and Blisters or "Tears" have Long Remained Buggaboos in Industrial Finishing. Electronic Equipment that Sets Up Charges To Draw Paint to Article Now Minimizes Overspray; Similar Devices, Working in Reverse, Remove Excess Paint and Prevent Unsightly Tears

the paint properly at an air pressure as low as 15 or 20 pounds per square inch. The solvent balance of the paint is adjusted so that the paint particles will stay wet a little longer.

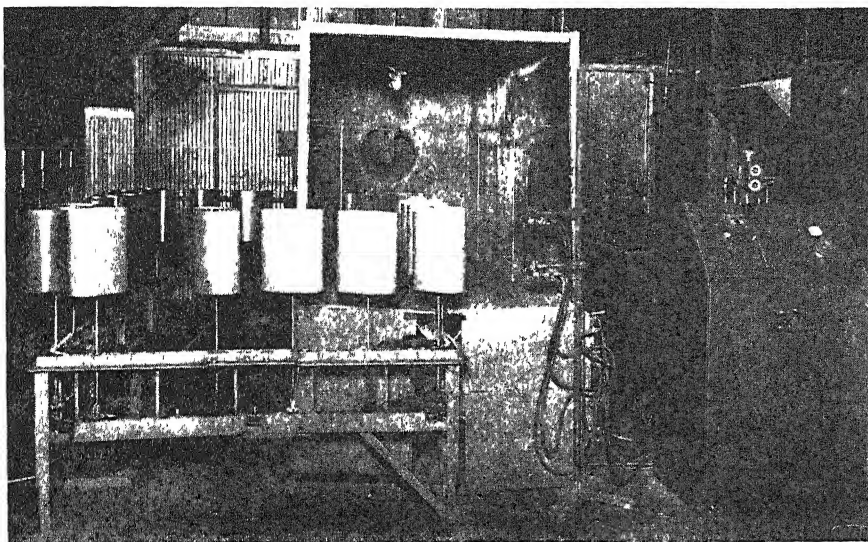
In operation, the paint leaves the spray guns and breaks into finely atomized particles that form a suspended paint fog. As each particle encounters the electrostatic field, it is charged with static electricity of opposite polarity to the metal wastebaskets moving along on the conveyor and instantly the electrically charged paint particles are attracted to the metal wastebaskets within the electrostatic spraying zone. The paint film is deposited smoothly and uniformly over the oppositely-charged surface. Paint particles which otherwise would miss the product being painted become electrically charged, changing their course and flying to the metal surface that attracts them.

The relatively low-pressure air stream carrying the wet paint particles makes it possible for the power of electrical attraction to draw to the product being painted most of

the paint which otherwise would be spent as wasteful overspray. The small amount of paint that does escape this electrostatic attraction, and the evaporating solvent fumes, are exhausted through the regular spray-booth exhaust system.

VERSATILE METHOD — A wide variety of products can be electrostatically sprayed. Whether or not the object is rotated during the process is determined by its size and general character. Such items as metal wastebaskets, radio tubes, water-heater jackets, lamp shades and bases, and cylindrical containers of all types, are rotated because their external symmetry readily permits such handling and increases the efficiency of paint application.

Flat stock, corrugated panels, small-diameter pipe, Venetian blind slats, and structural steel members can be coated either overall or on one side only, without rotation. They present to the electrostatic field and spray guns a flat extended surface which appears continuous



A complete electrostatic spraying set-up, such as this one for painting waste-baskets, includes electronic generator and controls at right, insulated leads to spray booth, and charged rods in booth. Gains in efficiency may be high

as the separate parts move along a conveyor.

Irregularly shaped articles that are not normally possibilities for automatic spraying can be coated by the electrostatic method, because of the extended area over which coating material is attracted to the items. Such things as automobile jacks, air cleaners, steering wheels, mouldings, mufflers, washing machine parts, and metal furniture are typical examples

EQUIPMENT USED—The electronic voltage source which maintains the necessary electrostatic field is a rectifying unit capable of converting the normal 220-volt, 60-cycle alternating current into rectified voltage of approximately 100,000 volts. The regulation of this voltage source is arranged so that the current delivered at this high voltage cannot exceed 0.01 ampere, a value considered safe for human beings. When the output of the unit is shorted through a low resistance, such as that of a person having wet hands and feet, the current does not exceed this value. Under normal operation the power consumption of the electrostatic rectifier is comparable to a 1000-watt lamp. Constructed without moving parts, the unit requires little maintenance. Only occasional replacement of tubes is required.

Any material can be applied by this method, so long as it can be atomized at the lower atomizing pressures used and can be adjusted in solvent balance so that a satisfactory wet film can be precipitated. Synthetic enamels, cellulose lacquers, aqueous suspensions, wrinkle and splatter finishes, oils, and some chlorinated-rubber type adhesives have been successfully applied.

The process is directly applicable

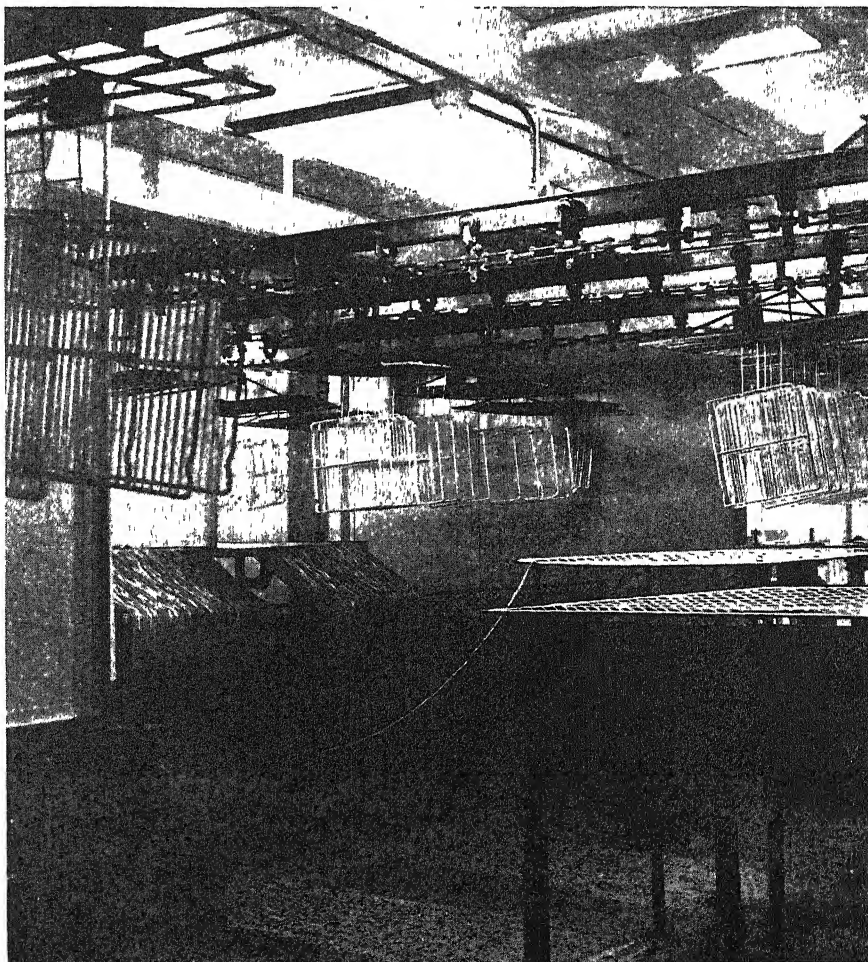
to article made of electrically conducting material; with non-conducting material, arrangements must be made for the part to become effectively a collecting electrode for the sprayed material. Flower pots, for example, can be inverted over a conical metallic fixture, flat sheets of acoustical tile or other insulating material can be laid upon a conducting metal-mesh

• LOOKING AHEAD •

More extensive finishing of irregular shaped articles. . . Reduced basic finishing costs. . . Further savings because fewer jobs are rejected at inspection. . . Cleaner, safer paint booths. . . Wider application of automatic spray equipment.

belt in order to form the necessary precipitating field over the surface to be coated

On flat surfaces, and items that can be rotated, the paint film is practically uniform in thickness. On other items, the uniformity of coating that can be obtained depends largely upon the contour of the part. Since the electrostatic field is responsible for the precipitation, the coating is light where the electrical field is weak, and normal where the field is strong. Thus, protruding sections receive more paint than recessed surfaces, whereas the internal coating of comparatively closed



Courtesy Servel, Inc.

De-tearing electrodes remove "last drop" of paint from dipped wire shelving

openings is practically impossible. On some objects the shielded or recessed sections can be satisfactorily coated by directing the spray guns so that such sections will be mechanically covered by direct spray, while the overspray from such guns reaches other parts of the object by the precipitating action of the electrostatic field.

ECONOMICS—The saving in material and labor that results from electrostatic spraying depends upon several factors. The replaced method may or may not have been efficient. On small parts, where ordinarily there is considerable overspray, great savings can usually be expected. On large flat sheets or similar areas where the usual hand or automatic spraying is somewhat more efficient, the savings are correspondingly less. In general, the adoption of electrostatic spraying may result in a saving of 40 to 60 percent of the material used in conventional high-pressure spraying.

An exceptional case was encountered in the spray painting of bazooka barrels. Here 75 percent of the paint used in former spray operations was saved. Painting Navy powder containers by the electrostatic method, although not exceptional in paint saving, did make it necessary to clean the spray booth only once every six weeks instead of twice daily as was formerly done.

"REVERSE" PAINTING — Another household product that has benefited from electrostatic processing is the refrigerator. In one 1946 model, the manufacturer wanted the finish on the wire food shelves to be as smooth as the gleaming interior of the box. A high-quality baking enamel was found to have an excellent appearance but spray painting the grid-like shelves was not practical for economic reasons. An automatic dipping process was found ideal but had the disadvantage that the enamel formed drops, or tears, and these became unsightly blisters after baking.

Now these drops of paint are pulled off electrostatically. The shelves are hung on the conveyor, dipped in the usual manner, then carried over a drainboard which returns the major part of the excess paint to the tank. On the way to the drying oven, when all but the last tears have drained off, the shelves pass over electrostatically-charged de-tearing electrodes. The electrodes exert an attraction of sufficient force to pull free these last drops or tears of paint while they are still in a fluid state. As a result, glossy white shelves of many sizes

and shapes continuously come to the inspectors and packers uniformly coated and free of excess material.

The electrodes used with this process are designed for the particular set-up involved, due consideration being given to conveyor speed and the type of article to be treated. Each "drain-off" point from which excess material is to be removed must be exposed to the electrode. If any drain-off portion of the coated article is electrically shielded from the electrostatic field by some other part of the article, it will be less effectively "de-teared" in proportion to the degree to which it is shielded.

The distance between the electrode and the article being de-teared is generally held fairly constant at eight inches. The conveyor speed, the distance between dip tank and de-tearing electrode, and the length of the electrode are arranged so that the freshly coated parts continue to pass over the electrode until all excess coating material is removed.



SLIDE-FASTENER RELIABILITY

*Improved by Electronic Control
In Manufacturing Process*

FLASHING neon lamps and synchronized control circuits in a dual pre-determined electronic counter are helping slide-fastener manufacturers to achieve exact length and precise spacing in their products. The counter, made by Potter Instrument Company, is set for the desired number of elements in a length of fastener, and the electronically-controlled machine does the rest. Greater accuracy and uniformity of product is attained, minimizing the possibilities of fasteners jamming.

MINIATURE RECTIFIER

*Takes Little Space, Has
Extended Service Life*

IF THE newly available midget selenium rectifiers are accepted by radio receiver designers and are not overruled by those who base the price and value of a set on the number of tubes it contains, there will be one less tube to burn out in the portable radio set of the future. The new rectifiers are about the size of a walnut and can therefore be mounted in places too small for a conventional rectifier tube and socket.

Only two soldering operations and a single mounting bracket are needed, since no filament connections or sockets are required. It is reported that the rectifiers will not break when dropped, and on continuous test have proved their abil-

ity to outlast several of the conventional 117-volt rectifier tubes. Starting is instantaneous, reducing greatly the usual warm-up period before a radio set starts playing. Currently, the rectifiers are made by General Electric Company in a size suitable for radios where voltages up to 125 volts are rectified, but larger units may come later.

FIRE DETECTOR

*Responds to Match
Struck 60 Feet Away*

SUNLIGHT and electric light contain very little energy below a wavelength of about 3000 Angstroms. Although the tungsten filament in a lamp may be hot enough to radiate in the far ultra-violet region below this point, the glass envelope is an effective filter. Flames and sparks, however, radiate in this region and advantage is taken of this fact in a newly developed fire detector that is extremely sensitive to minute sources of flame, sparks, and arcs. Detectors of this type can be installed in factory buildings and rooms to control a central indicating system for warning of an outbreak of fire. Some manufacturing processes that utilize flames and arcs might also use the unit.

The instrument consists of a specially designed Geiger-Mueller tube with a window that permits penetration by radiation below 3000 Angstroms. Its sensitivity is so great that it responds within one tenth of a second to the striking of a match at a distance of 60 feet.

MUST FLYING be a "Racket"?

Aviation, Now Finding Itself a Noisy and Unwanted Neighbor in Many Communities, is Starting a Search for Ways and Means to Silence the Roar and Clamor That, Continued, Might Cost the Industry Heavily

By ALEXANDER KLEMIN

Aeronautical Consultant, Research Associate
Daniel Guggenheim School of Aeronautics, New York University

A STORM of indignation against noise and hazard from the air is sweeping the country. T. P. Wright, the Civil Aeronautics Administrator, himself, leads the chorus of protests Congress has voted to build hundreds of airports, but when an attempt is made to locate one, nearby residents howl vigorously. Because of airplanes roaring overhead, they tell the Administrator, babies can't sleep, conversations are interrupted, and dishes rattle in the cupboard. Genial Ted Wright, as he is known to thousands of people in aviation, has his own personal grudge against noisy flying. "I am an old music lover," said he. "When Washington's National Symphony Orchestra moves outdoors and its music is drowned out by planes from the National Airport. . ."

Mr. Wright believes, however, that the airplane can and will be silenced. To suit actions to words, he has called for immediate research and engineering effort by all concerned. The public, unable of itself to take such long-range action, continues to suffer, but not silently.

A report typical of the pressing problem comes from Roy E. Carey, County Superintendent of Public Buildings, Union County, New Jersey. Here, low-flying planes often interrupt proceedings in the Elizabeth court house. "I shudder," says Mr. Carey, "when I see how close planes fly to the 320-foot building."

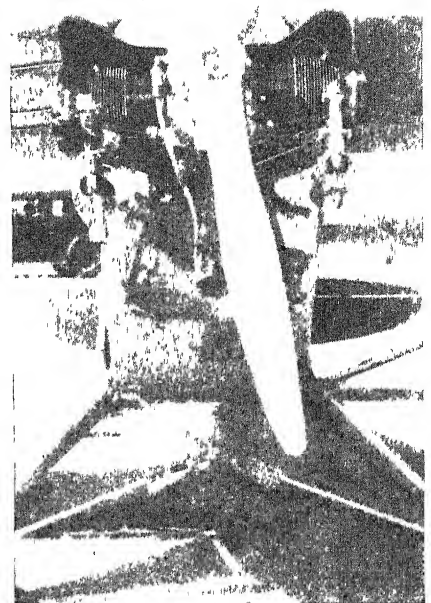
But courts and business activities are generally limited to daylight hours; it is in the quiet residential areas where aviation's noise problem literally strikes home with greatest

• LOOKING AHEAD •

Eventually a law requiring exhaust mufflers on all private airplanes. . . Better propeller design to reduce noise at source. . . Increasing familiarity will make the public less sensitive to overhead noise. . . Stricter enforcement of existing regulations by authorities. . . New noise problems when supersonic speeds are attained.

force Ben Stein, Assistant CAA Administrator, advises that residents of Alexandria, Virginia, near Washington National Airport, suffer keenly from the noise of transport planes. At peak traffic periods, airliners with engines at full throttle go over some of the houses at the rate of about sixty an hour, one a minute. The homes are located on hills and the planes pass very close to them during the early part of the climb, under such conditions, the invasion of residential privacy is almost absolute. Other areas report that chickens refuse to lay eggs because of the aerial disturbance. . . and new complaints are heard almost daily.

Grover Loening, nationally known aeronautical engineer and pioneer in aviation, summarized the situation in a recent speech before the Institute of Aeronautical Sciences: "I can venture a prediction. If we do not do something drastic, and right now, we are going to so limit the future of aircraft development that it will be just too bad for all of us. . . Just so long as the noise is going to militate against the estab-



Exhaust mufflers, one on each side of this light-plane engine, reduce noise considerably. Slight power loss gains added comfort for pilots and public

lishment of local airports and shove aviation out to the outskirts as an undesirable citizen, just so long will we remain in the stunt transportation class and not in a universal mode of travel."

From this it is clear that both the professionals and the public agree that the airplane is a noise nuisance and to some degree a public hazard. Which of the two evils is the greater is a subject worthy of examination.

DANGER FROM ABOVE?—Statistics make it apparent that the hazards—crashes involving injuries or damage to persons and property on the ground—are largely the responsibility of private flying. Commercial aviation accidents seldom occur in crowded areas but private aviation accidents are apt to concentrate on airports and their environs. Pilots show off, "buzz" houses, indulge in aerobatics too near the ground. Ben Stein states that one third of the fatal accidents in private aviation result from diving and zooming—showing off. Countering the colorful tales of such happenings, however, are facts to indicate that their very novelty and news value tend to exaggerate the danger to an extent unwarranted by their numerical frequency. Also, the accurate estima-

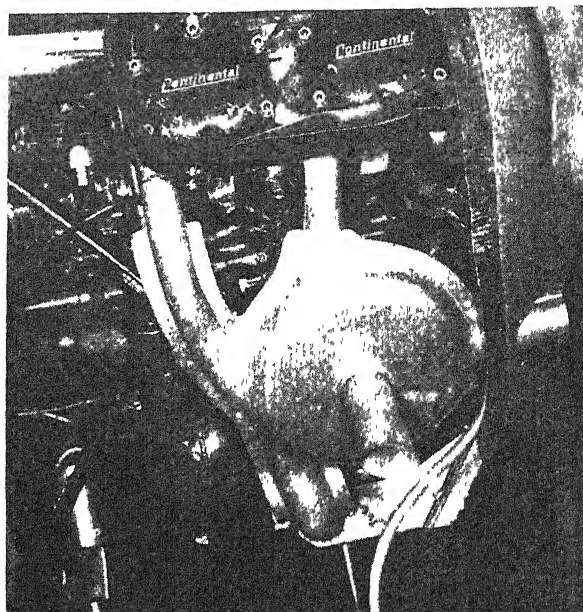
tion of a plane's altitude, while fairly easy for an experienced observer when the plane is directly overhead, is practically impossible when the plane is seen from an angle. Hence, the stories of planes flying at tree-top height sometimes mean only that the complaining citizen saw the plane through the trees—a different matter entirely.

For these and other reasons, it is now generally agreed that it is the noise and not the physical hazard which arouses the public, and it is here that the complaints find greatest justification.

NOISE INESCAPABLE — The noise level of a light airplane flying at minimum legal height over a community may be less than that of a truck in the streets or about the same as that of an automobile. The protests arise from the fact that airplane noise is overhead; it stands out in the heavens and fails to merge with the street noise. Consequently it intrudes itself in every home in range. Expert analysis and testimony to the effect that the airplane is not, after all, such a great offender as compared with street traffic is met, and correctly, with the reply that the public is not complaining about planes above crowded city streets but rather is concerned with otherwise peaceful neighborhoods located close to busy airports. Comparative figures along these lines, shown in the accompanying table, were gathered by the Aircraft Owners' and Pilots' Association from tests made by the CAA at a Pennsylvania airport. The planes used were the 200-horsepower Fairchild and the familiar 65-horsepower Piper Cub.

Since airplane noise is not a natural occurrence but an act of man, it might logically follow that someone in aviation is to blame for allowing the present conditions to arise. Actually, no particular group or agency deserves full condemnation and most have the fairly valid excuse that the importance of other things has eclipsed research on noise prevention. The airplane, engine, and accessory manufacturers have been busy seeking the highest possible performance and do not wish to do anything that will decrease speed, lessen payload, or increase cost. Silencing the airplane might do one or all of these things to some extent.

Airline operators, engrossed with the task of meeting a rush of patrons and harassed by a shortage of equipment, have not been able to devote a substantial amount of attention to noise. Airport managers, although appearing rather insensitive to complaints, have been partly at the mercy of their customers. And CAA,



Two views (left and on opposite page) of one muffler arrangement recently devised show stacks which lead exhaust into central expansion chamber. Inlets at cowl front are passages to heat exchangers that provide warm air for cabin and carburetor heating.

Courtesy Ryan Aeronautical Company

state, and police officials have, it would seem, been overly forgiving towards transgressors.

SOMETHING BEING DONE — Despite Ted Wright's forthright statement, and the public feeling which has been brought to bear, the noise problem has not yet improved physically. But those concerned have begun to work. The Aircraft Industries Association has responded heartily and has appointed a committee to investigate the reduction of noise at its source. The Air Transport Association, equally concerned and willing to help, has an engineering committee at work. The National Advisory Committee for Aeronautics is marshalling its unrivaled resources. Some manufacturers are already at work and civil authorities and airport managers are at least starting to keep closer tabs on activities under their jurisdiction. A beginning has been made.

The heart of the noise problem is three-fold; it lies in the propeller, engine, and exhaust. The so-called clatter of the working parts of the engine, as well as the aerodynamic noise of the plane rushing through the air, may be dismissed from the discussion as relatively weak and unimportant. It is from the propeller and engine exhaust that the genuinely loud and offensive noises arise. And even here it is estimated by the National Aeronautics Association that about 60 percent of the total noise originates with the whirling propeller which approximates the action of a fire siren.

Since the propeller absorbs power from the engine and translates it into thrust, it follows that the greater the power and thrust the louder the noise. Power, the very essence of flight, is not subject to reduction.

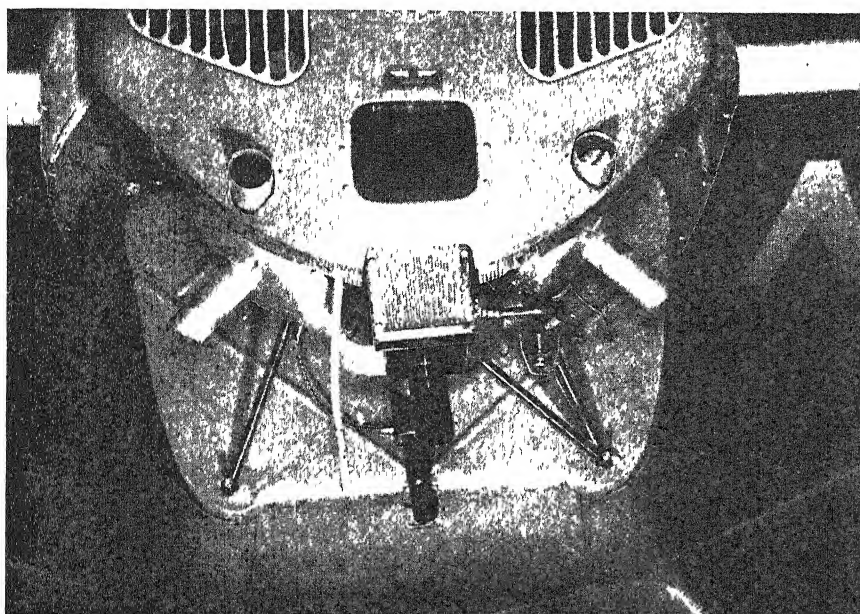
Therefore it is necessary to look in another direction; namely, the reduction of propeller speed, for any effective method of reducing noise from this source. Propeller-tip speed is the foremost consideration in this respect and when the thin blade tips approach the speed of sound—some 700 miles per hour—the noise becomes almost intolerable. In addition to the sustained air-pressure waves that batter the eardrums at such

NOISE MEASURED	NOISE LEVEL
Directly below plane take-off path	88-89 decibels
Aircraft circling overhead near airport as for landing approach	70-85 decibels
Normal peak noise level, plane passing within half-mile of field65-80 decibels
Truck noise, at point 230 feet from road; passenger car noise 10-15 decibels less in most cases observed ..	80-90 decibels
Transport airway traffic in the general airport area ...	74-81 decibels
Peak sound levels were generally of three to five seconds duration	

Matching of truck and airplane noise shows little difference technically. General public is not impressed with such figures because airplane noise is overhead and invades a wider area.

speeds there arises another tearing, swishing sound resulting from the vortices at the rear edges of the blades. This latter noise, less overwhelming than the tip roar, can be reduced by using thin but wide blade sections placed at a small angle to the airstream which strikes them.

From the standpoint of noise reduction, one golden rule may be drawn from the foregoing facts—keep the tip speed down by gearing



the propeller and by increasing either the number or diameter of the blades.

PRACTICAL PROBLEMS—Presented in this fashion, solutions to the propeller-noise problem appear relatively simple. It is only when an attempt is made to apply the solutions that the practical factors make it difficult. Dr. Theodore Theodorsen of the N.A.C.A. Langley Field laboratory suggested, for example, a revolution in propeller design that would involve a fan-like, eight-bladed arrangement turning at 500 to 600 revolutions per minute. The wide, thin blades of such a propeller would produce so slight a sound as to be inaudible at a distance of 50 feet away.

Airplane manufacturers, on the other hand, resist such devices because the gearing would be heavy, costly, and inefficient, and so would the propeller. Moreover, a variable-pitch propeller with its inherent complications would be necessary even on a small plane, and an appreciable penalty would be imposed on private flying. Clearly, some sort of a compromise must be found.

EXHAUST MUFFLERS — Approximately the same situation occurs in the exhaust muffler field. Opponents of these devices, so long used and required by law on motor cars, submit that the back pressure of the muffler reduces engine efficiency, that mufflers weigh too much, heat up, cause fire hazards, make the engine overheat, and reduce plane performance because of increased drag and lower power.

The National Aeronautic Association is of a different mind and voices its opinion: "An aircraft engine muffler involves some loss in performance, but there is no more rea-

son for an airplane to go blasting around unmuffled than there is for an automobile to do so, especially in view of the fact that a plane spreads its noise over a wider area. . "

Nevertheless there are but few people working on aircraft mufflers and the information regarding them is scanty. The general principle surrounding the mufflers is a simple one of reducing the velocity of the hot exhaust gases before they reach the open air. Momentary cooling in an expansion chamber accomplishes this and so does a series of baffles forming a tortuous route to slow down the noisy gases. The latter system, however, is open to some criticism in terms of lost efficiency and so on. Other exhaust silencing attempts by means of sound absorbing materials and acoustic filters to take out the more irritating frequencies have been discarded as too heavy or impractical.

In the case of larger aircraft, it is possible to put a portion of the exhaust energy to a useful purpose by using it to turn turbine superchargers. When this is done, a noticeable reduction in noise occurs.

Some of the light-plane manufacturers are now installing mufflers but for the most part their objective is greater passenger comfort rather than less noise for the general public. Ryan Aeronautical Corporation, for example, has produced a muffler for the 65-horsepower Taylorcraft which works on the general principle of expansion and fills two secondary functions in addition to reducing exhaust noise. By using the exhaust heat, this device warms the cabin and raises the carburetor air temperature as is desired by the pilot. The complete unit, built of stainless steel, weighs only eight

pounds. In use, it reduces engine noise appreciably and lowers engine power only about 2 percent.

Solar Aircraft Corporation, a well-known manufacturer of exhaust manifolds, has developed a similar three-in-one muffler which lowers the noise level at 25 feet distance by at least 35 decibels. Engine speed is reduced only 25 revolutions per minute and some 7000 British Thermal Units are available from the heat exchanger. When installed, two such mufflers weighing a total of 10 pounds are placed on each side of the engine. A short manifold connects each cylinder to a fairly long expansion chamber which is formed to facilitate heat exchange. The heater muffs are in two parts, demountable to expedite inspection and prevent cabin air contamination. A long tail pipe helps in the silencing process and reduces any possible fire hazard.

Both of the above mufflers are for light airplanes. Silencing a small engine of 65 to 100 horsepower does not appear overly difficult, but silencing 2000-horsepower and larger engines promises to be a much tougher nut to crack.

PILOTS CAN HELP—It is because of the tremendous engine power involved in air transport operations that the airlines are often considered the worst noise offender. Since technical solutions to the noise of high-powered engines do not seem readily available, other methods requiring the attention of pilots and traffic-control authorities are mandatory. The Air Transport Association Engineering Committee in one pronouncement says in part: "With propeller noise causing most trouble, the airlines should stress to their pilots the importance of reducing propeller revolutions as soon as possible consistent with safety after take off. They should stress altitude. They should channelize aircraft where possible in the interest of safety to keep them away from the more congested areas."

At least one terminal airport manager has recognized the signs of the times. Archer Armstrong of Newark Airport has presented the airlines with a five-point program that includes all of the foregoing recommendations with strong emphasis on the direction of flight after take off.

All in all, the problem of noise from the skies is a complex one that will require the co-operation of many agencies for solution. About the best that can be said at the present time is that a beginning has been made and that the public tone appears such as to demand that the good work be continued.

COMING CHANGES IN

DURING a war economics bows to logistics, then the cost of a metal, for example, may become secondary to its performance, availability, speed of manufacture, and so on. But in peace-time (or even the current reasonable facsimile thereof) the question "how much?" quickly resumes its all-powerful position.

Cost factors have always been decisive in engineering. In the metals field the price and supply of each material profoundly influence the extent of its general use as well as its suitability for a given application. Thus, other materials may be individually stronger or more machinable or more corrosion-resistant, but plain carbon steel remains the basic raw material for manufactured products because it is simultaneously the most abundant and the cheapest engineering metal.

Today manufacturers everywhere are closely watching and studying present trends and impending shifts in total mineral supplies, production volumes, production costs, and demand factors of individual metals, for clues as to what the relative supply and cost factors may be two, five, and ten years hence. Only with such knowledge can products now

in the dream or rough-idea stage be most effectively planned from both the functional and lowest-cost standpoints.

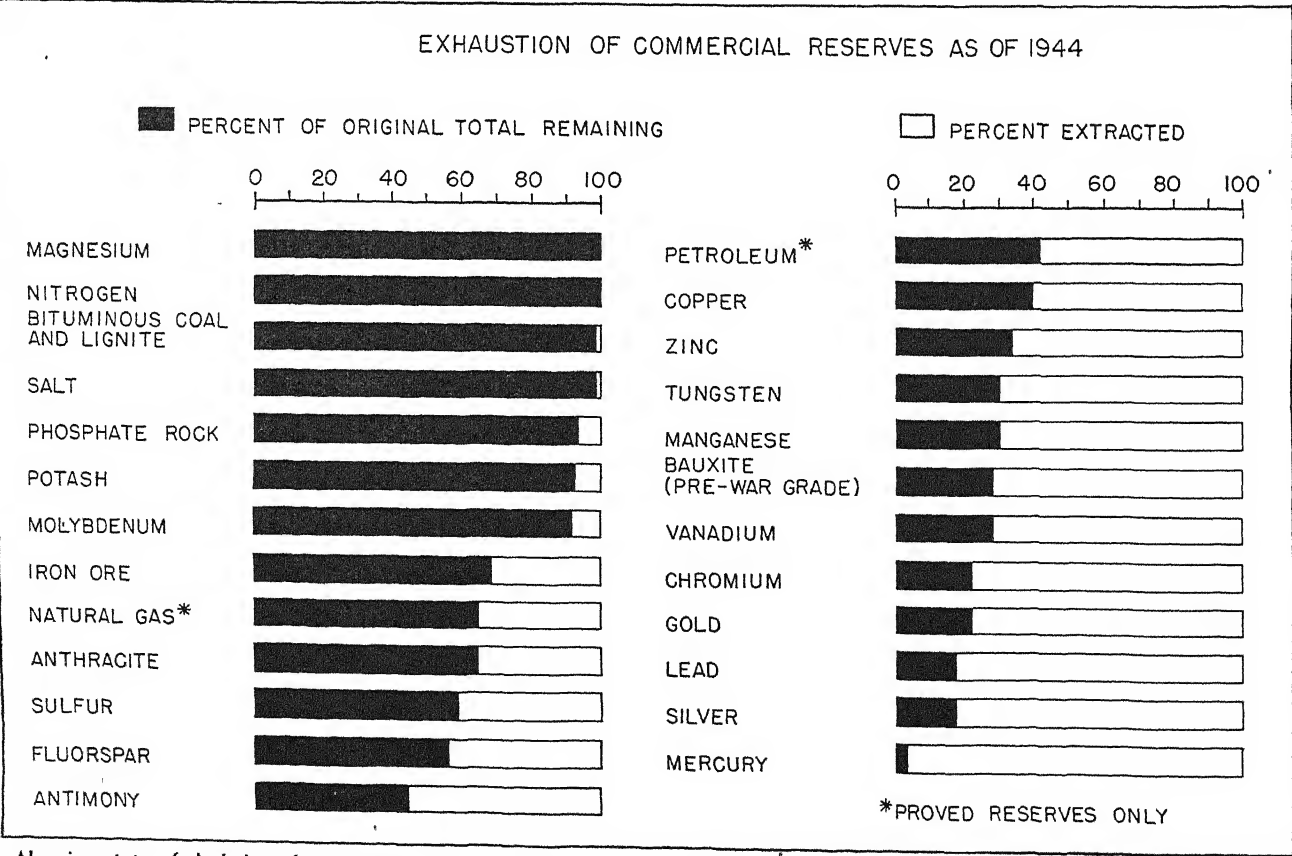
TREMENDOUS INFLUENCE—Some of these trends are startling even to expert materials engineers and will certainly exert a tremendous influence on the character of the automobiles, electrical appliances, household goods, hardware and small tools, airplanes, radio and television sets, homes and other buildings, furniture, and the like that will be produced a few years from now.

The trend toward lightness and mobility is certain to find the light metals in a better competitive cost position in 1955 than they are today. Copper, zinc, and lead will likely be more expensive a few years hence

than they are now. Steel will be less attractive economically than at present, although certain currently high-priced grades—that is, stainless steels—will be increasingly competitive on a cost basis and the development of lower cost mass-production finishes will aid our present Number 1 material to maintain that position.

The simple depletion—and in some cases the near-exhaustion—of certain mineral supplies is a leading factor in many of these forthcoming fundamental changes. Those that were heavily depleted by the war, such as copper, lead, and zinc, are certain to rise in price.

There are also many metals that will remain doubtful as to availability and price in this country, even when labor and general industrial conditions return to normal. Thus,



Alarming state of depletion of some once-common resources may be visualized from this graph—the implications to industry are clear

METAL-ECONOMICS

Survey of Trends in the Metals Field Indicates Wholesale Design Changes and a Complete Readjustment of the Thinking Which has Recently Dominated Procurement and Application of Industrial Metals

• LOOKING AHEAD •

Lowered reserves will throttle certain metals. . . Many costs will climb, but advantages of some higher-priced metals will intrench them firmly. . . Stainless steel, for example . . . Better knowledge of metal-working will influence material choice. . . Steel will remain dominant, but will yield somewhat, in some fields, to the light metals.

for mercury, the United States has only 3 percent of its original resources left, for silver and lead but 16 percent; for gold, 19 percent, for chromium, 20 percent, vanadium, 25 percent; for aluminum, only 25 percent of our pre-war grades of bauxite; manganese, tungsten, and copper are now at 30 percent, zinc at 33 percent. Our iron ore reserves, the most important of all, are at 68 percent. Of molybdenum, potent alloying element in steels, we still have 92 percent of our basic reserves. Only for magnesium has no dent been made in the level of our mineral resources, the magnesium figure still standing at 100 percent by virtue of the inexhaustible supply of magnesium minerals in the ocean.

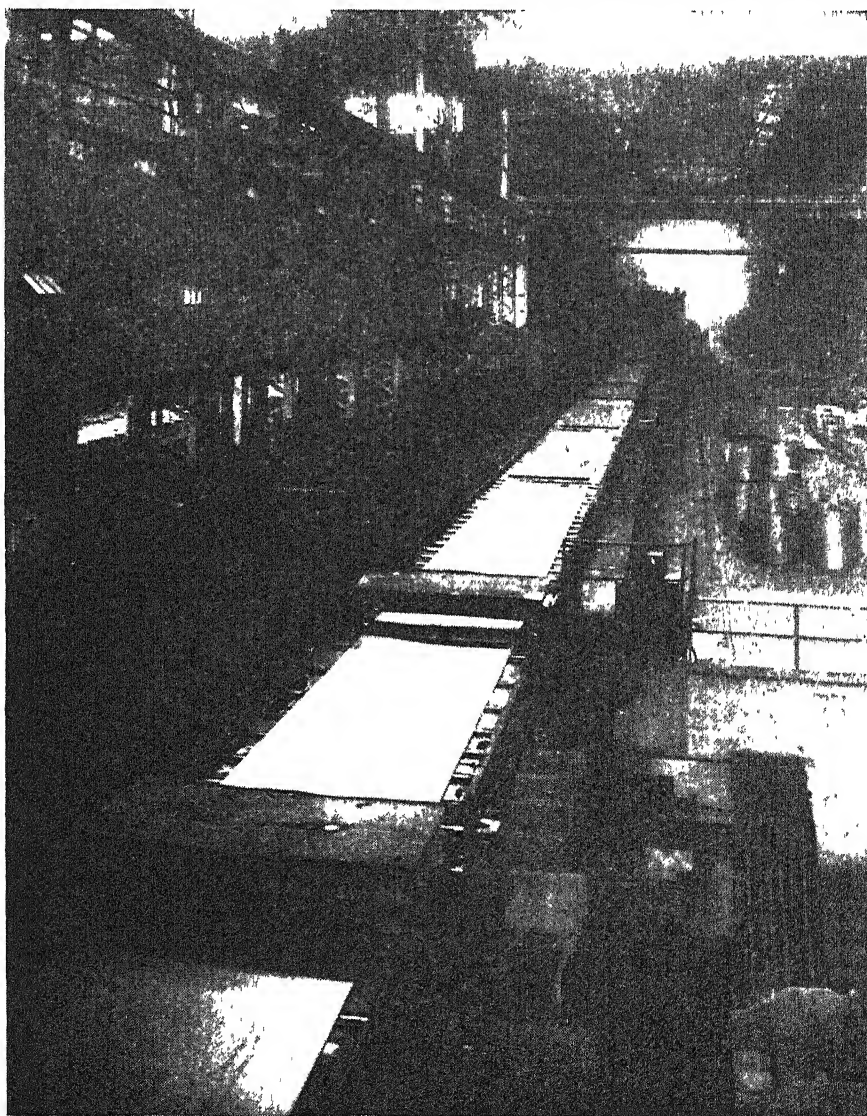
Tin and nickel are completely imported, the former over long distances and sometimes under the control of countries that may not always be friendly. Although virtually our entire nickel supply originates in Canada, the history and probable future of our relations with that country presage no difficulty whatever with our nickel supply.

But tin has doubtless become a metal which must henceforth and permanently be regarded as "not plentiful" and which may be at an economic disadvantage in this country in the future. This will affect the applicability of tinplate, tin-bronzes, high-tin solders, tin-base bearing metals, and other once-plentiful combinations. Already tinplate is

facing intense competition from aluminum and aluminum-coated steel, glass, and other container materials, aluminum, beryllium, silicon, and manganese bronzes are making inroads on the tin-bronze markets, the high-tin solders have failed to regain all the ground they lost during the war, and the tin-base babbits—still technically supreme—have been permanently replaced in

many applications by lead-base babbits, silver-lead coated bearings, and aluminum-bearing alloys. All of this is chiefly because of the supply or cost position of tin.

PRICE AND VOLUME — Today's price per pound of raw material, the traditional basis for economical selection of metals for specific applications, will be less influential as time goes on. The present base prices, for example, of aluminum and copper are close—aluminum around 15 cents per pound and copper 14.5 cents. But many metals are chosen and applied on a *volume* rather than a weight basis. A cubic foot of copper weighs about four times as much as the same volume of aluminum, obviously for products where the material is required to fill a given space, to make up a



Courtesy Republic Steel Corporation

Plain carbon steel from mills like this is still the leading basic metal. In time, its price advantage reduced, lighter metals may challenge steel's throne.

specified section-thickness, to provide a covering, and so on, aluminum will be much more economical.

One materials engineer has reduced four common engineering materials to a basis of cost-per-cubic-foot of semi-fabricated material, as follows: aluminum \$25, copper \$106, magnesium \$22; plastics \$30 to \$35. The strong position of the light metals in this lineup is at once clear, and when the powerful and increasing tendency to make everything light is considered, doubt ceases as to the rosiness of the ultimate future—the coming higher production volume and lower prices—of aluminum and magnesium.

On the other hand, the engineering properties of a high-priced material such as stainless steel are often so desirable as to make it economically more attractive than lower-priced metals. Although stainless steel costs 12 times as much as ordinary steel, it is occasionally found to be a “cheaper” material (say, for railway cars) because its much greater strength and corrosion resistance permit the use of sections only a fraction of the size of conventional steel sections and because the resulting lighter-weight cars cost less to haul and thus save money in power or fuel.

STAINLESS IS DIFFERENT—Again, the workability of a metal has a direct bearing on the economics of its use. Stainless steel is now considered a costly material to process, but actually it is not nearly so hard to handle as many people think and as it once was. As time goes on and better methods are developed, along with the education of the industrial public to the fact that working with stainless is *different*, not difficult, the consumption of stainless will increase and its price will decrease. “Material: Stainless Steel” will be a more common legend on the blueprints of 1956 than it is on those of today.

With labor costs skyrocketing and likely to remain in the upper realms, manufacturers from now on will consider the workability of a metal as one of the most important cost factors in its selection. The major production operation performed on metals is of course machining, so the machinability of a material, especially when translated into power required to cut it, is another important measure of its economic appeal. According to one set of widely accepted figures the power required to machine several common metals is in these proportions: magnesium 1.0; aluminum alloys 1.8; yellow brass 2.3; cast iron 3.5; mild steel 6.3; nickel alloys 10.0. Note again, the fav-

orable positions of the light metals in this procession.

In trying to estimate the probable metal-price trends of the next 10 years, it is also helpful to examine the nature and extent of price fluctuations in recent years. Here again it is found that copper, lead, and zinc have shown a rising tendency, which is expected to continue; the prices of aluminum and magnesium have been falling gradually, with a specific prediction for the latter of a 25 percent decrease within the next five years; and steel of all types as well as cast iron have maintained a surprisingly even price record.

The case of steel is particularly interesting in this respect. Even after the \$5 per ton rise early this year, the prices of steel were only 5 percent higher than the 1937 level. (Over the same period hourly wages rose 70 percent in the industry.) The steel industry is so large that its response to broad economic changes is sluggish; if steel prices had been brought into line with other prices, the recent rise would have been \$19 per ton instead of \$5.

It may therefore be expected that

TANTALUM

*Found in North America,
Will be Available for More Uses*

DISCOVERIES of new sources of tantalum near Ross Lake in Northwest Canada now promise more widespread use of this metal which has proved indispensable in electronics, medical, and chemical fields. Tantalum is a hard, ductile metal with high melting point that is resistant to most acids and inert corrosion. It is expected to find favor in high-temperature applications such as jet engines.

Heretofore tantalum has been obtained from Australia, Central Africa, and South America.

CERAMIC-COATED STEEL

*Resists Corrosion at
Elevated Temperatures*

TO PROTECT steel exhaust stacks and similar equipment from corrosion, new ceramic coatings, the key material of which is calcined aluminum oxide, are being applied to both surfaces of the steel. Applied in very thin coats, not over 0.002 to 0.003 inch and at 1600 degrees, Fahrenheit, the ceramic has a dull finish, such as is found in conventional porcelain enamels.

Even when the metal itself bulges slightly from the heat, no damage to the coating accrues. Also, these coatings resist failure under repeated

the increase in price of iron and steel products in general over the next 10 years will be smaller in proportion than the increases that may come in some of the other “older” materials. Don’t forget, too, that the economics philosophy in the steel industry is much like that in the automotive field, involving the largest possible volume of sales at a small profit per unit, and also that steel will fight hard to maintain its position as the leading basic industrial raw material—all of which will tend to hold down steel prices.

DESIGN CHANGES—When the current international, political, and labor uncertainties are removed from the industrial scene, many materials will return to reasonably abundant supply and their prices will find their proper levels. Look then for wholesale changes in the design of many familiar products, for costs and prices will again become the dominant factors in metal-selection—and the costs and prices of the common engineering metals are likely to be quite different in the future than they have been in the past.

thermal shock, protect against oxidation at 1250 degrees, Fahrenheit, resist cracking and blistering, and produce no glare.

A few of the applications will be automobile exhausts, stove parts such as inner liners of oil space heaters, burners on gas ranges, coatings for heating furnace tools, and pipe in natural gas fields that must resist hydrogen sulfide.

HEAT TRANSFER UNITS

*Achieve High Efficiency
With Light, Compact Structure*

NEW METHODS of fabricating heat-transfer equipment, originally developed for airplane use, now make it possible to produce units that are not only very efficient but are also extremely compact and light in weight.

The production process employs wafer-thin sheets of aluminum, stamped to form a series of half tubes on their faces. When two such sheets are fastened together by a special brazing process, a complete tube arrangement results. Sheet pairs are then assembled in groups so that a series of many tubes are formed into an air-tight unit arranged so that air passes through the tubes and over them as well.

The original use as an aircraft radiator is expected to lead to many applications in heating, air-conditioning, and related equipment.

Atomic-Bomb By-Products

Nuclear Knowledge, Even In Its Present Stage, Embraces a Wealth of Practical, Usable Material. Industry Will Benefit—Of This There Is No Doubt. Decentralization, Based on Atomic Power Plants Where Ordinary Power Plants Cannot Go, May be One Important Ramification

By HOWARD C. E. JOHNSON, Ph.D.

Chemical Editor, *Chemical Industries*

FIRST fruits of atomic "peace-fare" are already being harvested. Using the same techniques that produced the bomb, Clinton Laboratories at Oak Ridge, operated by the Monsanto Chemical Company, are now turning out radio-active isotopes to the number of almost a hundred.

When chemical substances are subjected to the bombardment of neutrons escaping from disintegrating uranium 235, they absorb some of these neutrons and form unstable atoms. Such atoms behave chemically just like the stable normal atoms, entering into the same reactions and forming the same compounds. But, and this is the important difference, they can always be detected by virtue of their own slow but continuous disintegration during which they emit particles and high-energy rays. Minute quantities of radio-active isotopes have been made for years by the cyclotron, a very complicated and expensive piece of apparatus, but the uranium pile now produces quantities sufficient for extensive research.

Much has been written about the use of radio-active materials for medical research and therapy. Vitamins, amino acids, and other essential fuels for the human machinery can be traced through the system by incorporating radio-active atoms in their molecules. The question of what happens to the sulfur in the eggs we eat can be answered by tracing a synthetic sulfur-containing amino acid made with radio-active sulfur through the body. Similar studies in nutrition, metabolism, drug action, and the like can be

• LOOKING AHEAD •

A host of new synthetics when isotopes show "how" as well as "what" happens in reactions. . . Future city sanitation plants operating on atomic power. . . Power for industry where coal, oil, and cooling water are not available. . . Greater use of "micro" research techniques to lower experimental costs. . . New instruments and devices borrowed from nuclear laboratories.

made with radio-active carbon, phosphorous, iodine, and other elements. Eventually these radio-active materials may be used to treat diseased tissues just as radium is used to treat cancer, but initially, at least, they will yield their greatest benefits as tools for finding the causes of disease.

INDUSTRIAL VALUES—The medical aspect of isotope usage has been so stressed that benefits to industry have virtually been overlooked. Many of the chemical products that are taken for granted—plastics, synthetic rubber, high-octane gasoline, to name a few—are formed by chemical processes which are relatively mysterious. The isotopes, because they are atom-sized "observers," can help to clear up the mysteries. Entering into a molecule to be swept into the reaction zone, they can "sit" on a molecule of catalyst for a moment and emerge again in a totally different type of molecule, thus telling continually where

they are by means of their constant, detectable radiation. It is easy enough to find out what happens when certain chemicals are brought together, it is far more difficult, usually, to tell how it happens. With the new knowledge that radio-active isotopes can provide, industry shall undoubtedly be able to design better equipment, discover more favorable operating conditions, and thereby direct the course of reactions into the most useful channels.

Other industrial benefits of radiation chemistry were described to the recent American Chemical Society meeting by Dr. Milton Burton, of the University of Notre Dame. He envisioned the city of the future operating its entire sanitation system as part of an atomic-energy plant—sterilizing its water supply, cleaning its waste, and producing new products from the by-product radio-isotopes.

Also, Dr. Burton thinks that the new materials may lead to new chemical processes, including the production of new polymers, both organic and inorganic; low-temperature cracking of petroleum oils; and more effective chemical use of some of our inefficiently employed natural resources. One possible wide application is the industrial use of "cold

RADIO-ACTIVE ISOTOPES NOW AVAILABLE

Accredited institutions for fundamental scientific, clinical, and technical research can now obtain useful quantities of C, Na, P, S, I, and other less common radio-active isotopes from Isotopes Branch, Research Division, Manhattan District, Oak Ridge, Tennessee.

Requests must be made through a recognized institution and the results of research must be published. Further details will be found in the accompanying article.

light"—the kind that lights up luminous watch dials—instead of incandescent light. A biological possibility is the production of animal and plant mutations. Thus the geneticist might accomplish in one generation what would otherwise take generation after generation of patient breeding.

New chemical reactions are a definite possibility, Dr. Burton asserted, because nuclear radiation is essentially of the same type as ultra-violet light or X-rays. Just as the latter agents promote certain chemical reactions, so might the more powerful and penetrating nuclear radiation

ISOTOPES AVAILABLE—Not all of the hundred or so isotopes are equally available; their availability depends upon to what extent they are produced in the pile reactions, how well they can be isolated from other reaction products, and how stable they are. Fortunately, among the more easily obtainable are the particularly useful isotopes of sodium, carbon, phosphorous, iodine, and sulfur. These are being sold at "out-of-pocket" cost to qualified institutions with the stipulation that results of research using the materials must be published. Fundamental research and human applications have first priority, followed by educational uses and applied research in that order.

The paucity of isotopes from the earlier cyclotron processes limited the scope of the research done and the number of persons who could use radio-isotopes. Nevertheless, many important results, particularly

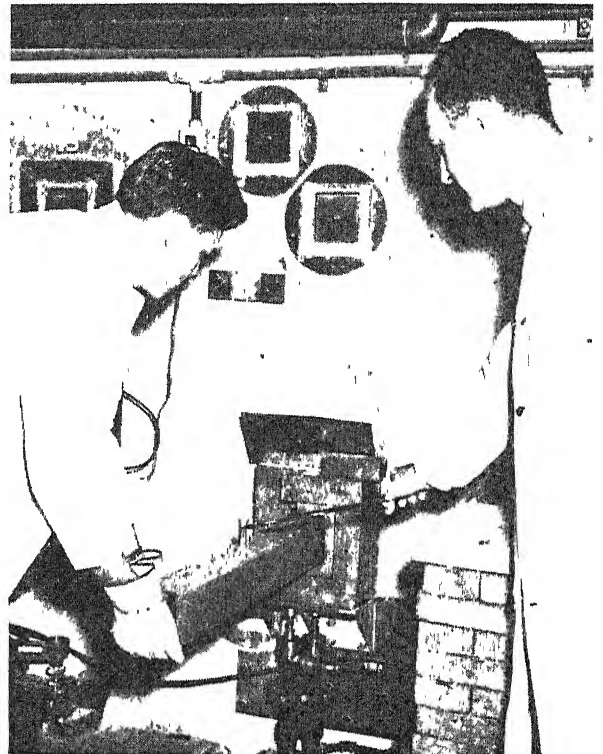
in biology and medicine, came from their use. Now, with the prospect of radio-active isotopes being made available on a large scale, even more important advances in all sciences can be expected.

No phase of atomic energy except the bomb itself has fired the public's imagination more than the attractive possibility of cheap, ubiquitous, and omnipotent atomic power. Scientists are becoming a little weary of all the glowing prophecies—automobiles with a fist-sized atomic engine, traveling from New York to Hollywood on a lump of uranium the size of a

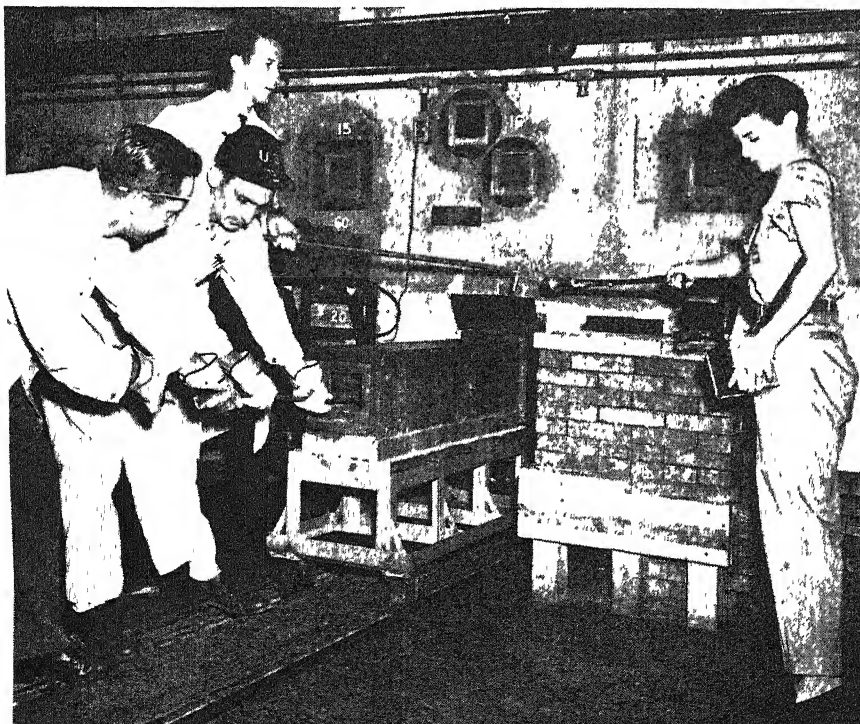
pea, rockets sizzling to Mars on a blast of nuclear disintegration.

ATOMIC ECONOMICS Such fantastic seeds of prophecy may bear fruit someday, but even now atomic power, as a present reality, is a force to be reckoned with. Dr. Charles A. Thomas, vice president of Monsanto Chemical Company and project director of this firm's Clinton Laboratories, told an American Chemical Society meeting recently that "a 75,000-kilowatt atomic energy plant could be built in the eastern United States for about \$25,-

At start of neutron bombardment (right), sample of the material to be made radio-active is inserted in graphite carrier block to be pushed into center of the uranium "pile." To remove material (below)—now radio-active—carrier block is pulled into lead shield to protect workers. Girl at right checks on radiation of sample. In both cases pile is inoperative while hole through shield is open.



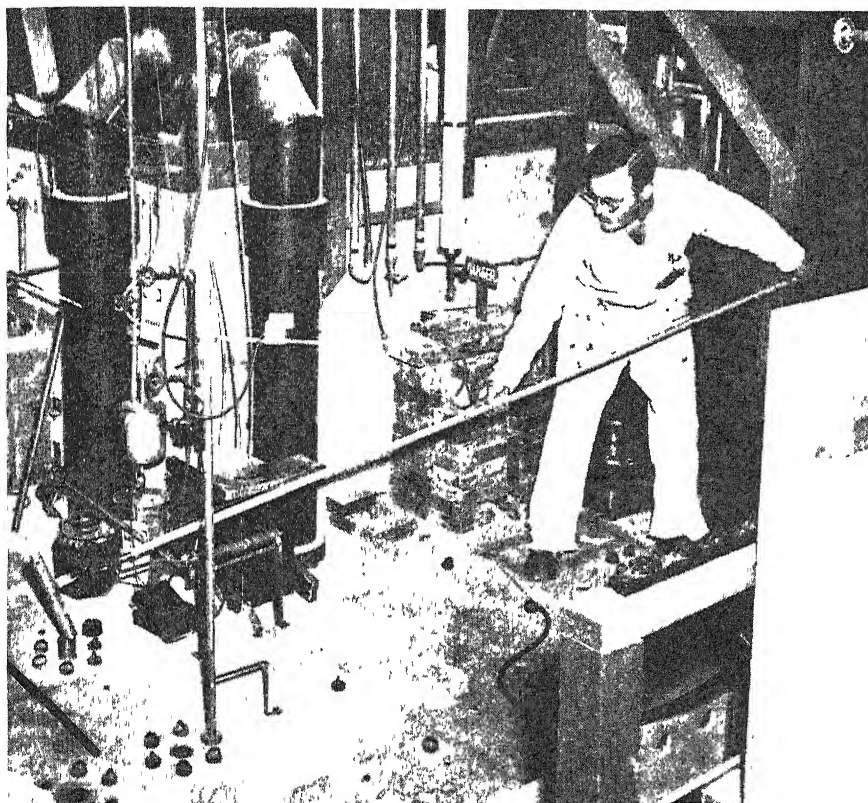
All illustrations Official United States Army Photographs



000,000. On the assumption that the plant would operate at 100 percent capacity and that interest charges on the investment would be 3 percent, the plant could produce power at approximately 0.8 cents per kilowatt hour. This figure has been computed by different groups of engineers working independently.

"A coal plant of the same output would cost \$10,000,000. Assuming capacity operation and the same interest charge on the investment, power would cost 0.65 cents per kilowatt hour with bituminous coal delivered at seven dollars per ton."

For those who question the value of such a project if atomic power cannot compete in cost with conventional sources, a logical answer is available. Coal accounts for about 60 percent of the operating cost of a power plant, and the cost of coal and fuel oil has increased greatly since the war and shows signs of continuing upward. If coal cost should reach \$10 dollars per ton, the costs of coal



Highly-active isotopes must be processed in special "hot" laboratories. Here, operator quickly drops sample through the roof of a heavily-walled concrete room where further treatment can be accomplished safely by remote controls

power and atomic power would be equal. Atomic power, on the other hand, is in an initial stage of development. Lower costs are dependent on successful solutions of numerous technical, operating, maintenance, and labor problems, but it seems reasonable that further exploration of the field will result in the standardization of design and construction, and a material reduction in investment and operating costs.

But atomic power should not be considered merely as a competitor of existing power sources, Dr. Thomas pointed out. "It is not altogether a case of nuclear power versus coal, gas, oil, or water power because the nuclear power plant has advantages and fields of application not open to other types of power-producing plants. Atomic power will not supplant but supplement our conventional power production."

It is predicted that the first atomic power plant will resemble an ordinary steam power unit. The turbines, electrical generators, and transmission lines will be of conventional design, but the furnace or boiler will be replaced by a chain-reacting pile, which must be heavily shielded to protect the operators from lethal radiation. A cooling fluid—possibly liquid bismuth—will flow through the pile to pick up the heat produced therein. Since this fluid will be highly radio-active, it will undoubtedly be awkward to use it di-

rectly for electric power generation or as a heating medium. Accordingly, a heat exchanger will be used to transfer the heat to water or gas. If water is used, it will be converted to high-temperature steam which can be used without danger in conventional turbines.

ATOMIC POWER PLANTS—Three broad applications for atomic power were outlined by Dr. Thomas: "Nuclear power plants would make feasible a greater decentralization of industry, a desirable factor in the world economy. Only a trivial amount of fuel need be brought in, and the need for a large cooling-water supply might be obviated by the development of gas turbines. Because nuclear plants lend themselves to decentralization, more economical industrial combinations should develop."

"The nuclear power plant," Dr. Thomas continued, "will aid in the industrial development of isolated parts of the world where the cost of oil, gas, or coal is prohibitive and where a supply of water is unavailable. This is possible, for a nuclear power plant, if combined with a modern gas turbine, will make unnecessary a supply of any such fuels or cooling water."

As for the third field: "The nuclear power plant, in connection with the modern gas turbine, might be desirable as an operating or

standby plant, to existing large utilities. Unlike hydro-electric power plants, nuclear power plants are able to supply process and heating steam directly in addition to power."

Such plants, it was pointed out, might be integrated strategically with present utility systems to reduce the cost of power transmission and insure partial operation of the system in the event that the standard power stations were inoperative. The problems in the construction of an atomic power plant appear difficult, Dr. Thomas ceded, but not insurmountable.

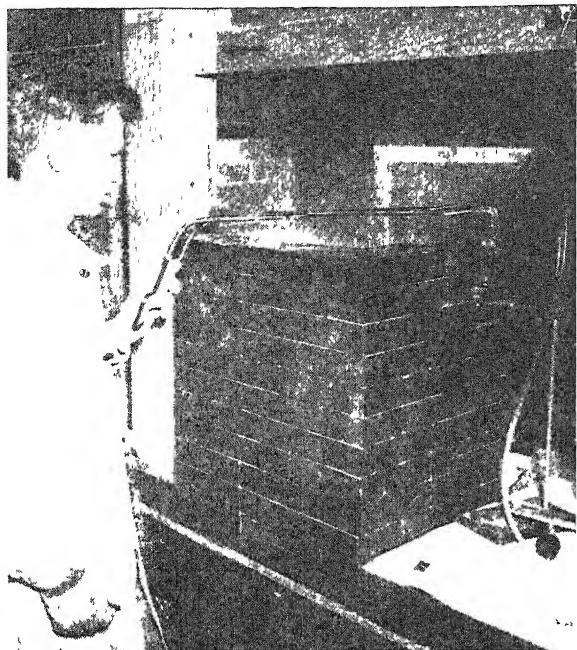
INDIRECT BENEFITS—So far the direct benefits of nuclear fission, radio-active isotopes and atomic power, have been considered. In the near future it may also be possible to enjoy some of the indirect profits of the Manhattan District work.

Among these profits are the new techniques and new equipment which had to be devised to solve the unprecedented problems with which the atomic scientists were confronted. In order to weigh accurately the infinitesimal amounts of some of the radio-active materials available, for example, an ultra-microbalance was developed which may be useful in micro-chemistry. Also, the great amount of work with uranium hexa-fluoride gave impetus to the rapidly expanding field of fluorine chemistry, leading to the commercial production of the gas and many of its useful compounds. In the process of declassification are new chemical products and new equipment designed to facilitate production of fissile materials. Many of these will undoubtedly find use in non-atomic chemical engineering.

Perhaps one of the more unusual contributions of the Manhattan District will be to the philosophy of chemical engineering itself. The atomic scientists designed and built a full-scale atomic plant on the basis of data obtained from micro test-tube experiments. It might be most uneconomical for industrial chemical companies in general similarly to abandon pilot plant procedures, but the same ingenuity that made possible the remarkable feats at Oak Ridge and Hanford may alter the conventional conception of pilot plants and lead to more intelligent engineering.

Some of the peace-time benefits of atomic energy described are already available; others will take years of patient work by men who know what they are doing.

In order to provide such men, Monsanto Chemical Company has started a one-year training course for a selected group of 35 scientists



Radio-isotope sample, too small to be seen in beaker, is dried in this "semi-hot" laboratory where materials not excessively radioactive can be processed safely in well-shielded and well-ventilated hoods. Mirror allows operator to view sample, long tongs, gloves, and smock are necessary for protection.

and engineers. Representing both industrial research institutions and leading universities, the group will participate in the research and development program of Clinton Laboratories as well as study nuclear physics and radiation chemistry. The program will be continued if the first course is successful.

As a result of their studies these men should be prepared to carry on atomic research in their own laboratories, delving into the mysteries of this comparatively infant science and bringing to fruition the incalculable benefits that now lie latent, waiting only for discovery.

⊕ ⊕ ⊕

FLUORINE

Marketed for First Time—In Pressure Cylinders

MOST chemically active element known, fluorine has now been put on the market for the first time. The gas is available in steel, pressure cylinders on a limited commercial basis for experimental use by manufacturers and researchers.

Hundreds of uses for fluorine may become possible with the availability of it in its elemental form. One of these uses is as a non-flammable, non-toxic liquid with a high enough boiling point and specific gravity to replace mercury in the present mercury-vapor boiler, thus making the efficient vapor engine practical and safe. Another use is for a gas, already developed but requiring elemental fluorine to manufacture, which is a nearly perfect insulator for the high voltages used in X-ray and nuclear physics. Also possible is the development of a lubricating oil

so stable that it will not oxidize or break down under any present engine or mechanical operating conditions and which will make possible gears and engines heretofore only dreamed of by designers.

Other uses for fluorine compounds now definitely within the realm of possibility include heat-transfer and dielectric media, more effective insecticides, fungicides, fumigants, germicides, stable solvents, anesthetics, fire extinguishers and fire-proofing materials, resins and plastics, and weed killers.

The rapidity with which fluorine combines with almost all other elements—it will burn both glass and water—has been the greatest stumbling block to its isolation and research on its use. But the great stability of most of its known compounds is perhaps their chief value. Freons, widely used as refrigerants since 1930 and as the propellant for insecticides in the "bug bombs" used by the thousands during the war, demonstrated this. Dyes made from fluorine compounds have unusual brilliance and color fastness.

The biggest problem in the project of making fluorine commercially available was packaging the gas after it was manufactured. The fact that steel and copper will resist fluorine corrosion well at normal temperatures was a great help, but detailed research was necessary to develop gaskets to make the present containers leak-proof and safe. A comparatively small amount of the gas is packed in each cylinder at present — one-half pound at 400 pounds pressure.

The gas is produced by the Pennsylvania Salt Manufacturing Company in an especially designed electrolytic cell containing potassium

fluoride and hydrogen fluoride at about 100 degrees, Centigrade. The products of this electrolysis are hydrogen and fluorine. A special diaphragm extending into the electrolyte is necessary to prevent these two gases from combining explosively. Another problem in manufacture is the complete elimination of water from the cell, since in its presence the process gives off oxygen instead of fluorine.

WILD GINGER GERMICIDES

Said to Compare With Penicillin, Compositions Unknown

AT LEAST two substances shown to be highly germicidal have recently been extracted from wild ginger, which grows over most of the north-eastern section of this continent from New Brunswick to North Carolina and as far west as Manitoba, Missouri, and Kansas. Research workers C. J. Cavallito and J. H. Bailey, of the Winthrop Chemical Company, have found two substances, present in this plant to the extent of about 20 parts per million, which have been shown on preliminary tests to have powerful bactericidal effects on pus-forming organisms. The substances apparently do not harm the common intestinal organisms.

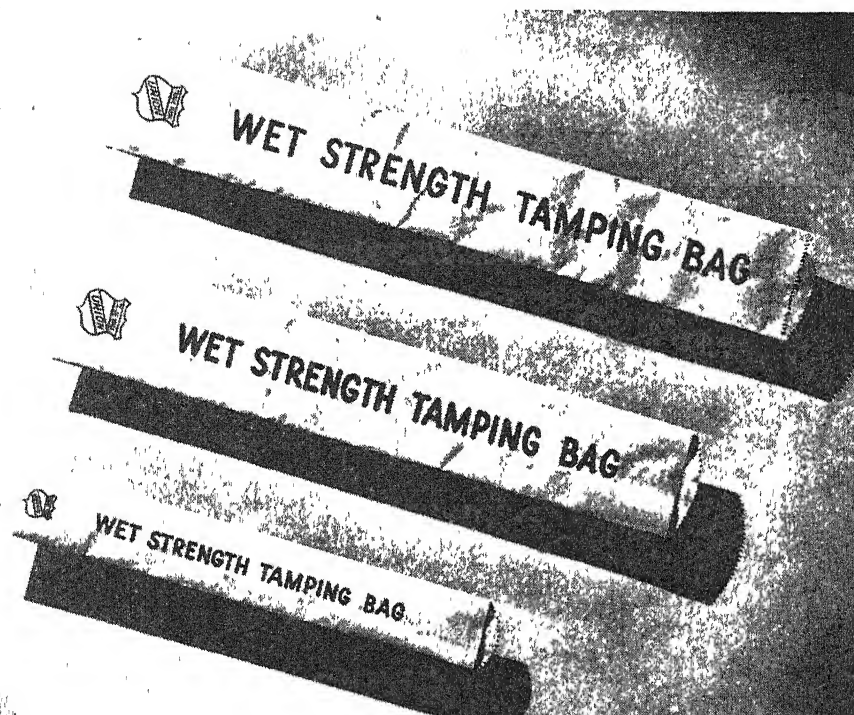
The discoverers state that the effectiveness of the new compounds, whose natures and compositions are not yet known, is of at least the order of magnitude of penicillin, if not actually greater.

COAL MINES

May Become Power Plants With Fires Underground

INSTEAD of being removed from the mine, coal may be burned at the source to produce power in the future, according to Professor Roger Adams, head of the Chemistry Department, University of Illinois. "Just as sulfur is melted in the ground and pumped out in liquid form, it is not too fantastic to believe that with cheap oxygen, such as has been discovered in the Soviet Union, coal may be burned in the mine," states Professor Adams.

"The heat generated in the gases and the subsequent burning of the carbon monoxide would provide the power for a utility plant near by," he explains. "The carbon monoxide might also be reduced to petroleum. With the present conditions in the coal industry, investigations of this kind may be stimulated which, by past experience, generally result in inventions or discoveries for replacement of labor by mechanized processes."



Emblematic of the wet-strength paper's toughness are these bags to be stored in a damp mine, then packed with moist sand as a backing for explosive charges

Paper Gets Webbed Feet

Paper's Renowned Weaknesses When Wet have Long Prevented Its Use In Many Packaging Applications. Now, the Addition of Resins to Pulps Permits the Manufacture of Bags that Can Go Swimming if Necessary

By WARREN L. BASSETT

TO THOSE persons who have had a wet milk bottle soak its way through the bottom of a paper bag, news of paper with high wet-strength will be welcome. It will be even more welcome to the manufacturer who must pack a water-damageable product with the full knowledge that somewhere along the line carelessness or necessity will probably result in his containers being exposed to the elements. Backing this news are records proving that such substances as sugar, flour, and other perishable products in bags made of this remarkable paper have been stacked in the open by the tons—without damage from rain, snow, or steaming tropical humidity. In some areas where standard ship unloadings are impossible, it has even proved practical to dump the paper-bagged merchandise bodily into the ocean. The bags hold together without difficulty and eventually the cargo drifts ashore.

RESIN BINDERS—The secret behind these extraordinary performances of paper lies in synthetic resins, plus perfection of multi-wall bag construction.

Urea-formaldehyde or melamine

resins, when added to paper pulp while it is still suspended in water, adheres to the paper fibers, subsequently binding them tightly together. The resultant sheet, even when soaked with water, retains a high percentage of its dry strength, and does not break. Moreover, it regains its full strength when dry. Its tensile and bursting strength are increased, as is also its folding endurance; it develops a high resistance to scuffing, or rubbing, whereas ordinary paper, when wet, breaks or rubs through readily.

The first application of resins to the paper industry took place just before the war, with the result that when the supply of wood, metal, textiles, and glass for packaging became scarce, this new type of tough, strong paper was available. The Army and Navy requisitioned nearly 100 percent of production, and it was used in many combinations with

other types of paper to produce containers which were not only water-proof, but also grease-proof and corrosion-proof.

Called "wet-strength" paper by the industry, this product today is causing a revolution in many industrial and retail packaging methods, and has opened up scores of new fields for paper and paper products. It is, for example, being extended to such ordinary paper articles as toweling, tissues, diapers, blueprint paper, shelf and wall papers, and many others.

Paper toweling treated with resin is much stronger, and does not disintegrate in the hands. Thus it takes less paper to do a hand- or face-drying job. But it is in the fields of industry and merchandising that wet-strength paper, in the form of multi-wall shipping sacks and various bags for retail use, is making its greatest strides. The jobs this paper

• LOOKING AHEAD •

High-flavor foods bag-packaged without loss of volatile essences. . . Better brand identification for produce now sold in bulk. . . Longer wear for bank notes, business papers, and roughly handled blueprints. . . Reduced shipping losses through water damage . . . Less freight car and warehouse contamination from leaking bags.

is doing are not glamorous, but they are of tremendous importance to the industries involved, representing advances in speed, efficiency, and economy over previous practices. As a result, paper bags are replacing rigid containers in many industries.

MULTI-WALL BAGS — Packaging experts estimate that today more than 300 commodities are being shipped from plant to consumer in heavy-duty, wet-strength multi-wall shipping sacks constructed of as many as six plies of paper, often bound together with asphalt laminations. These commodities cover a broad field of "loose solids," such as flours, sugars, salts, powdered chemicals, fertilizers, cement, and so on, which are required to be handled out of doors under all types of weather conditions.

Multi-wall bags are custom-made for each product after careful study of its properties, the type of protection it needs, and the conditions under which it is shipped and used. Exhaustive laboratory and shipping tests are made until the right bag is found. Such experiments are necessary because of the many functions

a multi-wall bag can be made to perform. In addition to protection of the contents from absorption of atmospheric vapor, and vice versa from loss of essential moisture, such bags can offer protection from damage by water for as long as 24 hours of immersion, and for much longer periods when subjected to spraying by water.

Equally vital may be avoidance of loss of flavor or essential oils, as well as contamination from other matter outside the package. Frequently, bacterial contamination and insect infestation are included in the latter. Some products require prevention of seepage or penetration because they are put into the bags in liquid form, and sifting which might occur with finely powdered products—of particular importance when the powder is toxic—must be eliminated.

Other important factors include resistance to abrasion and scuffing from the outside, and undue wear from contents when they are sharp, gritty, or coarse. In some cases, pro-

Paper containers that don't weaken when wet are ideally suited to packaging frozen foods or ice cream (right).

Wet-strength bags (below) were responsible for a new business since ice cubes could be stored in them indefinitely for delivery to the customers whenever they are needed.



vision for easy stripping of the bag from the contents, such as asphalt, synthetic rubber, and so on, which are put in the bags in liquid form and later harden, must be made. And almost always the quality of being easy to stack neatly to any practicable height is a requisite.

So rapidly has the use of multi-wall bags spread in industry that they are being produced at a rate of better than one billion a year by the paper industry. And new uses are constantly being found. Only recently large meat packing plants started to ship meat trimmings—for conversion into ground meat and other products—in multi-wall bags of wet-strength paper provided with special liners for protection of the product from contamination.

RETAIL REVOLUTION—Just as interesting are the important changes being brought about in the retail field by wet-strength bags. The newest trend here is toward pre-packaging, which means delivering to the merchant a commodity in a package

of retail size which he can sell without further weighing or handling. This has been found to reduce both costs and waste, and in many instances to increase sales, because the products can be easily and quickly picked up by the customer.

In the food field, for example, a newly developed wet-strength bag, made by Union Bag and Paper Corporation, is altering the merchandising of fresh fruits and vegetables because it permits them to be pre-packaged in take-home quantities while they are still wet from washing or refrigeration. This bag is fitted with a window of cellophane through which the contents can be seen by the purchaser. Pre-packaging of some staples such as oranges, dried peas, walnuts, and so on, is not new, but heretofore it has never been possible with fresh produce because of exterior wetness or mois-

ture content. Another big obstacle was the fact that ordinary bags completely enclose their contents, making the purchaser feel he is getting a "pig in a poke." Through the windows of the new bags, however, shoppers can see the quality of the products they are buying.

The bags reduce waste because 100 pounds of produce, pre-packaged and priced at so much per bag, bring the full price for 100 pounds, whereas 100 pounds of the same produce, sold by clerks from open counters or bins, suffer a large loss through overweight selling, shrinkage, and spoilage. Bruising through pinching and handling by customers is also eliminated. Prompt packaging while the produce is still fresh is also a large factor in the reduction of waste, since over-ripe specimens are eliminated before they can contaminate others.

The new bags speed up sales because they remove fruits and vegetables from the slow, individual, clerk-sold category to the quick shelf, or self-service field. Application of color printing to the bags, often including an attractive replica of the product they contain, enhances eye-appeal, and permits store and brand identification to be placed where they will convey their messages most effectively.

Another wet-strength bag, minus the cellophane window and resembling the ordinary kraft grocery bag, has solved an old and annoying shopping problem. It is being widely used by retail stores to package cold milk, beer, and other beverage bottles which "sweat" their way through a regular bag. It is also being used for cartons of ice cream, frozen-food packages, and many other wet or damp objects.

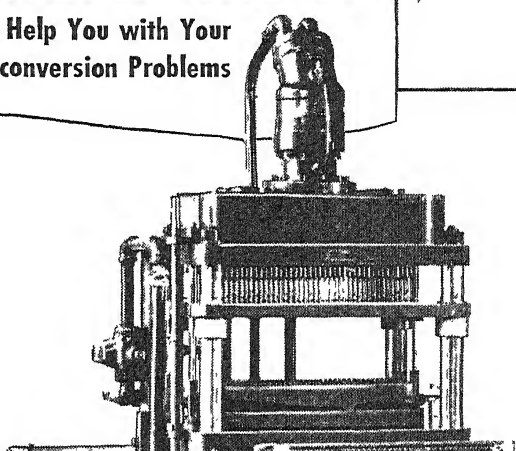
PAPER MATCHES PRODUCT —

Other types of wet-strength bags made, in many cases, to the user's specifications, are now packaging a wide variety of products, including potatoes, onions, ice cubes, coal, charcoal, charcoal briquets, greenhouse plants, dog food, and many others which have a high moisture content, which are packaged, shipped, or stored under conditions of rain or high humidity, or which are wet or moist when packaged.

This year millions of pounds of potatoes are going to market after being cleaned, graded, and pre-packaged at the shipping point in wet-strength bags of 10-, 15-, and 50-pound capacity—the popular quantities—which supermarkets and other stores can offer directly to the public without further handling. The bags absorb and dissipate—without breaking—the moisture from bruised

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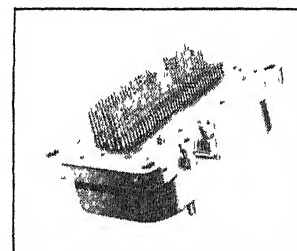
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or broken potatoes and, what is more important, the condensate moisture which drips from the roof and walls of cars due to the sharp humidity changes which often occur between shipping points and the terminals.

In the ice industry a new and profitable service is being built on wet-strength paper bags—the sale of cracked or cubed ice, in various weights up to 50 pounds. A number of companies are now offering this service to restaurants, hotels, bars, and large group entertainments which find themselves short. Deliveries are made on receipt of a telephone call, and the filled bags are stored in bins until needed.

Coal and other shaft mines have also discovered the wet-strength bag and are using it in large quantities in the shape of tamping bags, made up in sizes varying from 1 1/4 inches by 12 inches to 2 inches by 18 inches, according to the size of drill. They are filled with sand and tightly tamped in behind dynamite charges so that but little of the force of the explosion is lost through the drill hole. The bags withstand both the filling process with damp sand, which takes place in the depths of the mine, and storage in the damp, humid atmosphere there.

In pondering the uses of wet-strength paper, an industry expert recently drew up a list containing

115 possibilities. Not all of these have been fully explored, but some of the more interesting include advertising posters, bank note papers, bed sheets, pillow cases, Bible papers, chart paper, cigarette paper, decalcomania paper, diploma parchment, innersole board, lithographic paper, leather-board, music manuscript and music roll paper, photographic papers, seed-germinating paper, obstetrical sheet, shopping bags, tea-bag paper, and tree-wrap paper.

Because paper is still in short supply, and likely to continue so throughout 1947, the industry champs at the bit when it considers the possibilities of wet-strength paper. Already faced with a demand it cannot supply, it knows that present applications have barely scratched the surface. But research goes on; new and unusual applications of this product can be expected in the future.



RADIANT MURALS

*Use Plastics "Light-Piping"
Ability to Achieve Effects*

A NEW decorating medium, "painting in light"—the use of luminous walls, murals, and pictures—provides both illumination and decoration without the use of conventional lighting fixtures. Designed for homes, hotels, restaurants, and theaters, the new wall decoration is based on the "light-piping" property of Plexiglas.

Light, introduced at the edge of a Plexiglas sheet, will travel indefinitely within the sheet until it reaches an engraved or painted design, which releases the light to the surface and hence into the room. Thus, designs scribed, etched, or painted on a plastics sheet become luminous and glowing, offering decorators, architects, and muralists a new decorative material with infinite possibilities.

The murals used in one such installation range in size from 30 by 40 inches to 36 by 48 inches. Each mural is individually mounted in a shadow box, and illumination is furnished by fluorescent tubes mounted within the boxes. The murals act not only as decorations, but as light sources to supplement ordinary room lighting.

Another possibility, three-dimensional murals, have been found especially effective in large rooms. They are produced by engraving parts of the design on two or more sheets of Plexiglas which, when assembled, produce an entire scene. The edge of each sheet is colored as desired, and when edge-lighted the complete scene appears in light and color as well as in three dimensions.

Almost endless variations for this process have been demonstrated. If desired, some of the engraving can be placed on front and back of all but the front sheet. The back surface of each sheet reflects more light

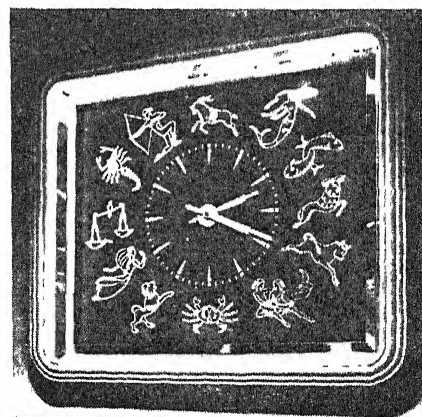
Glowing uniformly against an opaque background, engraved designs in these acrylic plastics panels are lighted from concealed sources at their edges

but the reduced brilliance of front-surface reflection may be useful in certain designs. Paint and engraving may be combined for still further modification of the result. The distance between the sheets may be varied or each of the sheets may be of different thicknesses. In some cases, according to the Rohm and Haas Company, the designer may find it desirable to cut out sections from one or more of the sheets. If color is added to the edge thus formed, light of pleasing tint may be thrown on some other part of the design.

COLOR CHANGE

*Reveals Temperatures
In Gas Turbines*

THE GAS turbine, which has thus far literally refused to have its temperature taken, has now been forced to take its own temperature through use of a special metal alloy. The alloy shows a marked color change for every 25 degree change in temperature from 500 to 700 degrees, Centigrade, then reverts back to its original color and begins the color scale over again in a higher



range of from 725 to 900 degrees, Centigrade

Believed to be the highest temperature ever recorded accurately inside a gas turbine, such intense heat would amount to 1652 degrees above zero on an ordinary Fahrenheit thermometer, were it able to record that high.

The temperature-taking alloy, according to General Electric engineers, turned the tables on the gas turbine after practically all types of complicated temperature measuring devices had failed to record faithfully the intense and varied



heat created by the turbine wheel, which whirls more than 1000 miles per hour.

By making turbine parts of the alloy, the turbine has no alternative but to take its own temperature. Following operation, the turbine has to "show its colors," and by doing so also has to show the temperatures that were reached by its parts during operation.

A chrome cobalt composition, the alloy changes color like most metals when being oxidized under heat. Unlike other metals, however, this alloy oxidizes so slowly at higher temperatures that each color change occurs regularly at 25 degree intervals, thus permitting actual graduated color scale according to temperature. At 500 degrees, Centigrade, it turns a light straw color, at 525 a straw color, at 550 a bronze color, at 575 purple, at 600 dark blue, and so on. At 700 degrees, Centigrade, it turns light blue and according to all precedent, it next should turn grey, indicating the end of the color scale.

Instead of turning grey, however, the alloy at 725 degrees, Centigrade, reverts back to a light straw color and begins the progression of colors over again.

WOMEN CHEMISTS

*Cited for Good Work,
Discrimination Held Shortsighted*

REPORTS of discrimination against women in the chemical profession are now being heard, according to the American Chemical Society "Now that the war is over certain organizations are replacing women chemists with men," says *Chemical and Engineering News*, a publication of the Society. "Further, some concerns are discriminating against women in recruiting new professional personnel This is both an unfair and a very shortsighted policy." The journal continues: "It is our considered opinion that the entrance of relatively large numbers of women into the chemical profession has had a most beneficial effect. The country is and will continue to be short of competent chemists. Old-fashioned prejudices should be cast aside and applicants judged solely on their training and competence."

ICAROSCOPE

*Uses Phosphor Screen to
Show Planes Against Sun*

A DEVICE which enabled pilots to spot enemy airplanes speeding toward them directly in line with the sun was recently revealed under the name "Icaroscope," when Dr.

Brian O'Brien, professor of optics and physics at the University of Rochester, described the telescope-like instrument before a meeting of the Optical Society of America. Named after the Greek mythological Icarus who flew too close to the sun, the Icaroscope takes advantage of what is known as afterglow in a phosphor screen which stores up energy when excited by radiation of short wavelengths or high energy particles. In the Icaroscope as used by Navy pilots it soaked up sunlight.

The image, such as an enemy plane in bright sunlight, is formed on a transparent phosphor screen

while the screen is hidden from the eye. A double rotating shutter then closes off outside light and the pilot sees the image 1/100 second later. By this time the brilliance of the sunlight on the phosphor screen is only 20 to 50 times that of the surrounding sky as compared with the sun's real brightness which is 10,000 to 100,000 times that of the surrounding sky. The result is that a plane can be seen on the screen silhouetted against either the sun's disk or the brilliantly illuminated surrounding sky.

The disks are rotated by an electric motor at about 100 cycles per second so that the viewing appears to

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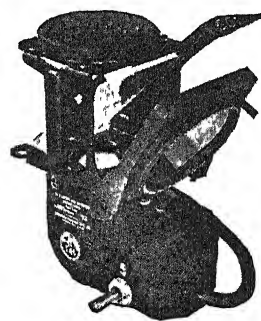
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BOMBER SIGHTING STATION—A double end Periscope Type Instrument of highest precision 6 ft tall, shipping wt 350 lbs Orig. cost \$9,850 Consists of numerous Lenses, Prisms, Mirrors, Gears, Motors, Metal Parts and Electrical Gadgets.

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SPECTROSCOPE SETS . . . These sets contain all Lenses and Prisms you need to make a Spectroscope plus FREE 15-page Instruction Booklet
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(Illustrated Book on Prisms included FREE)

be continuous as in a high-speed motion picture camera. The instrument was used extensively in observing and photographing the Bikini atom bomb tests.

AIRPORT RUN-ABOUT

*Carries Freight or Passengers
Quickly and Economically*

A NEW motorcycle and trailer combination is now being used for quick pick-up and delivery of freight, as an "errand boy" around the field, for transport of personnel, and for other airport jobs. Equipped with vacuum brakes, the trailer has a capacity of 180 cubic feet, weighs 900 pounds, and will carry a load up to one ton. The rails of the trailer pull down, forming seats to accommodate 10 people. With an ordinary load, the Indian motorcycle averages about 50 miles to the gallon. The combination is used by Air Freight, Inc.

NEW FABRICS

*Created from Older Materials
By Addition of Chemicals*

TEXTILE chemicals which will now improve the quality, durability, appearance, and comfort features of all fabrics, are described as capable of adding chemical sinews to both natural and synthetic fibers. As a result, rayons, cottons, and wools of the future will have a variety of virtues they have never had before, with benefaction to the consumer.

This family of textile chemicals includes Resloom, a melamine resin which creates rayon, cotton, and woolen fabrics with marked wash-

able, non-shrink, muss-resistant, and long-life qualities; another resin which makes cotton, wool, and rayon water-repellent; Syton, a colloidal silica, which anchors the threads of nylons and rayons to prevent runs and slippage; a new impregnated thread of unprecedented tensile strength for sewing of linings, preventing seam-splitting; a mildew-resistant agent, an organic amide insuring full protection against moths; a soluble resin developed as a sizing agent; and a synthetic colloid as a sudsless soap detergent. There is also a fire inhibitor nearing perfection but not quite ready for the market, with which textiles can be rendered so nearly flame-proof that a drape or dress treated with it will never be a fire hazard.

Resloom, one of the chemicals, is a soluble resin and the cloth is immersed in solutions running as high as 20 percent. After the excess moisture has been removed the fabric is subjected to a temperature up to 350 degrees, Fahrenheit, which cures the Resloom deposits into a hard but pliable plastics to which the fibers cling. Because of its toughness, Resloom shrinks very little, hence the fibers which cling to it are also prevented from shrinking.

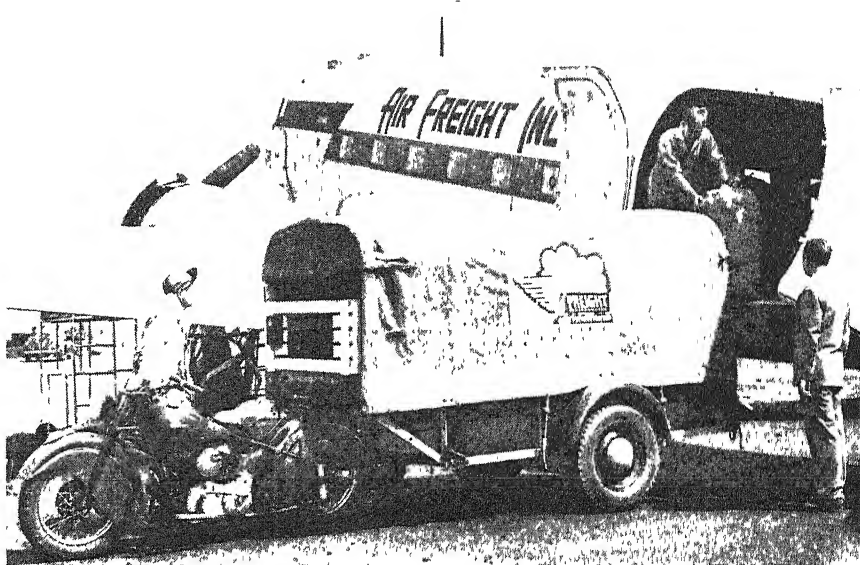
Another quality which is often described as plastics "memory" causes the Resloom to resume the position it held when cured, no matter how badly wrinkled. Thus, when the flat surface of clothing is creased by sitting or crossing the knees, it later becomes flat again because of this "memory." As explained by the Monsanto Chemical Company, there are additional advantages because rayon containing 10 percent Resloom, for example, is cheaper than an equal weight of untreated fabric since the cost of the resin is less than the cost of the fine yarn it displaces.

PLASTICS "MAGIC" KIT

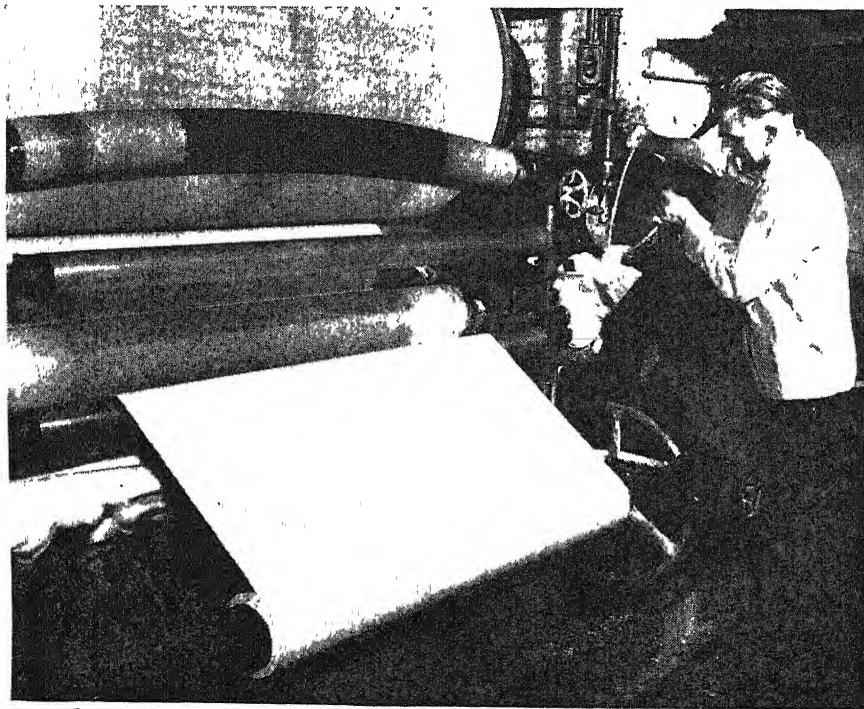
*Interestingly Demonstrates Unusual
Properties of New Materials*

DESIGNED to occupy the same place in the plastics field that chemical sets do in the chemical field, a new kit of "magic" tricks and experiments, in the form of a large illustrated book, contains quantities of plastics materials necessary to perform various experiments.

Called Plasto-Magic, the set was designed for hobbyists from eight years old up, and for those who want to become familiar with the properties of plastics in common use today. It contains 28 color pages, directions, and a wide variety of solid



Shown here as freight carrier, trailer is quickly changed for passenger use



Rayon, passing through wrinkle- and shrink-proofing resin solution at the mill

plastics mounted on the pages, together with bottles of liquid plastics and accessories held in cushion pockets conveniently placed in the back of the book

According to the designers, Plastic Products Company, Inc., the experiments involve bending light around corners, making shining letters with edge lighting, creating three-dimensional scenes; permanently reproducing remembrance pin and ring insignia, making phantom designs, and writing with invisible ink letters that turn to frost. The materials also permit making luminous shade and light pulls, building an unsinkable life raft, and taking advantage of the other peculiar properties of plastics in many novel experiments

Working materials mounted in the book include polystyrene, polyvinyl alcohol, lucite, polyethylene, neoprene, nylon, acetate, Tenite, vinyl, vinyon, thermosetting plastics, and others. Brief descriptions of each plastics are given, together with instructions for making useful and ornamental personal and household articles.

A list of materials in large quantities is supplied with each set for those who desire to go further into an investigation of the possibilities of plastics

BUS TRANSPORTATION

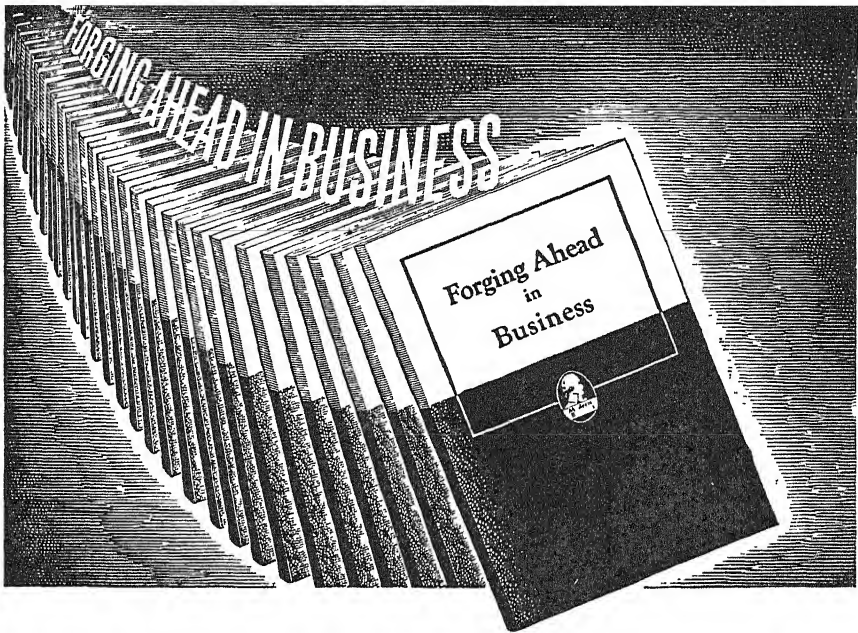
*Promises Many Comforts
On the Highway*

MOTOR BUSES of the future will possess, among other attributes, pressurized, air-conditioned passenger compartments, individual radio sets, circulating ice water, retiring rooms; inside destination signs operated by push-button; Polaroid windows, turbine-electric drive; and speeds of 100 miles per hour on suitable highways.

This vehicle of the future is pictured by L. H. Smith, engineering vice president of General American Aerocoach Company, as an engineering possibility. He suggests that atomic energy ultimately might be used for propulsion, but for the immediate future directs attention to turbine-electric drive combinations operating on two fluids mixed in transit to comprise a safe and powerful fuel.

He proposes such additional features for tomorrow's motor coach as, power steering, hydraulically operated doors, electric defrosting of windows, individual draft control, public address system, and built-in automatic fire extinguishing system

Mr. Smith estimates that fares would be on the order of one and one-half cents a mile.



All Serious-Minded Production Men SHOULD HAVE THIS FREE BOOKLET!

FORGING AHEAD IN BUSINESS contains a message of particular importance to production men. This is your opportunity to obtain a copy of this famous book, which has been described as a "turning point in the lives of literally thousands of men!"

Although "Forging Ahead in Business" has been distributed to more than 3,000,000 men, today's timely edition was written in the light of recent worldwide developments. Its 64 pages represent more than three decades of successful experience in training men for leadership in business and industry.

It demonstrates the method which the Alexander Hamilton Institute uses to give you immediate help in your present position, while preparing you for post-war opportunities. Subjects directly related to the work you are doing now, **PLUS** other subjects of fundamental value to the business executive, are discussed in the book and placed in significant relation to one another. Thus, a helpful, over-all picture is provided.

Said one man who had sent for "Forging Ahead in Business":

"In thirty minutes this little book gave me a clearer picture of my business future than I've ever had before."

... and that represents the opinion of

the Institute's 400,000 subscribers, including 134,000 production men!

The booklet further explains how it is possible to offer this essential training in a minimum of time; how the Institute program fits in with the most crowded of post-war schedules.

Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp., and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

**Send for
"FORGING AHEAD IN BUSINESS"
TODAY!**

Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail coupon below.

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Firm Name
Business Address
Position
Home Address

New Products and Processes

SILICONE OIL

*Speeds Molding of
Mica Electrical Parts*

FASTER and improved production of molded mica parts has been reported by the utilization of a silicone oil as a mold release agent. The silicone oil is being used as a lubricant in molding both shellac and Glyptal-bonded mica and it is reported that the application results in a freedom from carbon and other decomposition products which adversely affect the electrical properties of the mica.

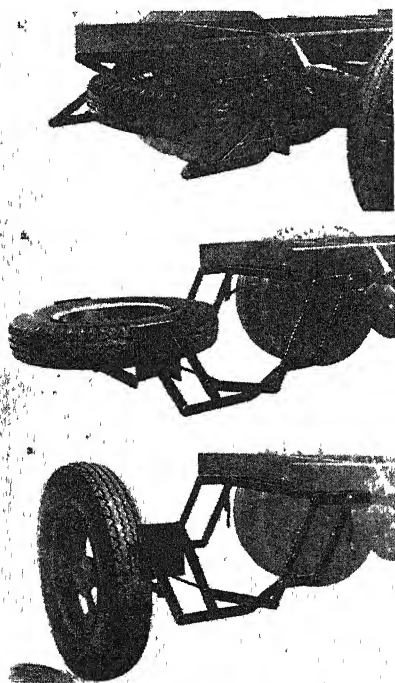
Also, a marked reduction was gained in rejected pieces caused when parts were broken in being removed from the mold. This feature of the silicone oil, plus the fact that its use saves time formerly spent in cleaning gummy decomposition products from the mold, has resulted in greater production, according to General Electric Company.

In addition, the high-temperature stability of silicone oil together with its low surface tension enables the mold operator to apply it readily to all sections of the mold while still heated.

HEAVY TIRES

*Easily Handled on Road
With Jointed Carrier Rack*

CHANGING of heavy truck tires and wheels is said to be reduced to a one man job with a new tire carrier that requires no straining or lifting to re-



Three steps in moving tire from rack show why heavy lifting is unnecessary

move the spare and replace the flat. Even tilting to upright position for rolling is done without lifting.

To change a tire, the holding clamps are released and the cradle portion of the carrier which holds the tire and wheel is pulled out and away from truck body to a position where the tire is clear and can be tilted upright while it is still attached to the carrier. The tire then rests on the ground and when detached from carrier by removal of the holding clamp, it may be rolled to wheel requiring replacement. Returning the flat to the carrier is essentially a reversal of this procedure.

The device, called the Ted Tire Carrier, is bolted to the chassis frame of truck, trailer, or bus either at the rear or side and is constructed to withstand a load stress equal to four times the load it carries under normal use.

COIN-CHANGER

*Supplies Vending Machine
Patrons with Nickels*

A FULLY automatic coin-changer, which collects five cents for merchandise and makes change for dimes and quarters, promises to be a new convenience for customers of vending machines who find they do not have a nickel handy.

In use, the customer may deposit a dime and get the desired merchandise and a nickel in change or, if a quarter is deposited, the merchandise and four nickels in change are returned. The coin-changer also accepts nickels to deliver merchandise alone.

In addition to its use in machines vending merchandise such as candy, chewing gum, carbonated beverages and milk, it is believed that the coin-changer has possibilities for adaptation to amusement games; bus and train station lockers; streetcar, bus, and subway turnstiles, and token dispensers. The device is manufactured by Bell Aircraft Corporation.

APPLIANCE CORD

*Moulded in Elastic
Coils of Synthetic Rubber*

TO OVERCOME tangling of cords for heating irons and other electrical appliances, a new type of coiled cord has been made available that not only prevents kinks but cuts down repairs. By covering the wire with neoprene, it was possible to mold the spirals without depending on springs or other mechanical devices.

Tough and resilient, the synthetic-rubber coating stretches freely and comes back as the coils are elongated and retracted—the cord will stretch

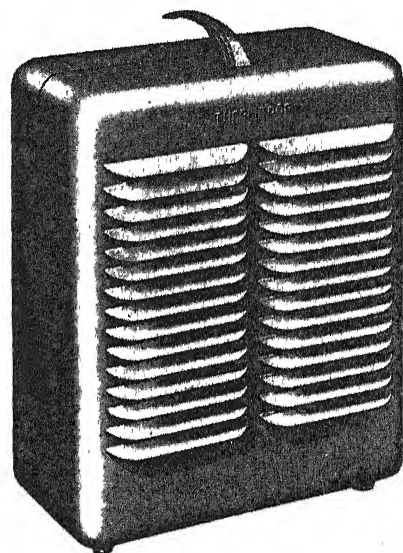
six times its coiled-up length. In compact position, the cord is about a foot long. Lasting service is claimed for the cord because neoprene, made by Du Pont, resists abrasion and tearing and will withstand heat if the cord happens to touch the iron momentarily. Other domestic uses are foreseen on toasters, hot plates, portable washers, vacuum cleaners, and room heaters.

The Koiled Kord, as it is called, is manufactured by Kellogg Switchboard and Supply Company.

PORTABLE HEATER

*Uses Forced-Air System;
Doubles as Cooling Fan*

FOR USE in factories, shops, warehouses, and garages, and claimed to be more efficient and economical than the ordinary, convection-type electric portable heater, a new heater operates on the forced-air principle in which the heat is drawn off the circular heating coils by a quiet-operating, four-bladed fan



Does not depend upon air convection

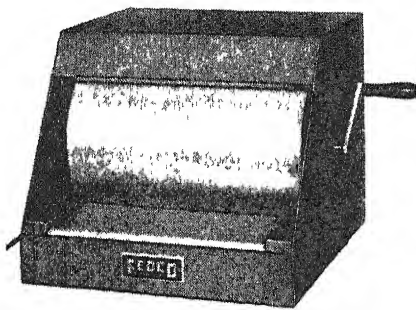
and forced out and down through a horizontal grille. With the heating element switched off, the fan may be operated individually to circulate cooling air in summer.

Called the Master Duty Heat Fan, the unit weighs 19½ pounds, and is 19¼ inches high, 14¼ inches wide, and 8½ inches deep. It is available with thermostatic control or with rotary-range type, four-position switch. Other specifications include a 230-volt polarity-type plug; four-pole, induction-type motor; available in 3000-, 4000-, or 5000-watts capacity; and a thermostat on each heating unit that automatically breaks the circuit if an object prevents delivery of air to heater. The heater is made by the Thermador Electrical Manufacturing Corporation.

PHOTO DRYER

*Is Compact in Size,
Fast in Operation*

FOR PHOTOSTATS, copy prints, and blueprints, a new dryer is reported to dry as many as 120 photostats per hour.



High-speed print dryer, electrically operated, cannot scorch the prints

The dryer occupies a bench space 18 inches square and is 15 inches high. Its heating system, inside the drum, consumes 300 watts and, as described by Fedco Products Company, is controlled to such an extent that prints cannot be scorched. A newly developed device enables the electric current to reach the heating element without the use of slip-rings. The Drum Dryer operates on 115 volts, either A.C. or D.C.

BRASS CLEANER

*Has Long Active Life,
No Tarnishing Action*

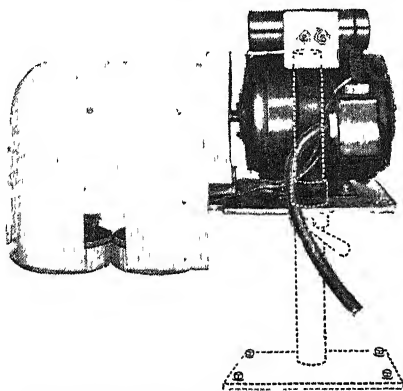
STATED to have high detergent ability and, in addition, having no tarnishing action on active metals including copper, brass, bronze, nickel-silver, tin, and lead, a new alkali brass cleaner can be used as a general plating room cleaner for cleaning of steel and the metals listed. The material's qualities make it suitable for soak or electrolytic cleaning. It can also be used for scrub cleaning because it does not contain strong alkalis.

A feature of the cleaner is long life during operation due to stable surface-active materials and buffered alkali balance.

BAG SEALER

*Reduces Pulling and Distortion,
Handles Many Types of Jobs*

A DOUBLE-DRIVE, low-priced, rotary heat sealer for bags, pouches, and so on, is thermostatically controlled to seal a wide range of heat sealing materials, can be operated horizontally, vertically, or at an angle, and can seal any length bag, pouch, or carrier. "Double-Drive"—the driving of both sealing roller shafts, thus eliminating



Over 300 lineal inches per minute;
both of the roller shafts are driven

pulling or distortion of the bags as they travel through the sealing rollers—is one of the principal features of the sealer, called Fast-Tite.

According to the manufacturer, Pack-Rite Machines, speed is another feature—up to 300 or more lineal inches per minute, depending on material being sealed, called Fast-Tite.

are used; wiring is directly to the stationary-ring heating units under transite plates covering both sealing rollers. A tension adjustment is provided for pressure on the sealing rollers. Choice of sealing krumps—vertical, horizontal, or checkered—or flat seal is also available.

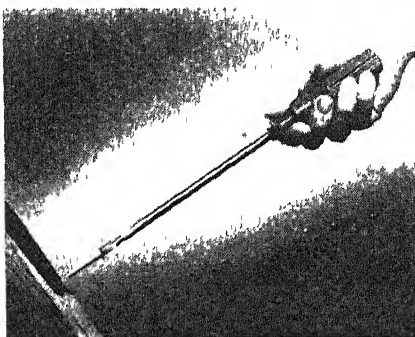
Intended for long use, the Fast-Tite is described as light weight and compact.

WEDGE-ACTION SCREW DRIVER

*Grips Screw Slot
Firmly, Releases Quickly*

LIGHTWEIGHT, practically unbreakable handles of Tenite plastics are used on new screw-holding screw drivers, designed for speedy setting and driving and for use in hard-to-get-at places.

The double blade of this tool is encased in a steel tube which, when pushed forward by means of a plastics push button, separates the blades to hold the screw securely and keep the tool from slipping off as the screw is driven. When the tube is pulled back, the blades come together so that the tool slides out of the screw slot. The pentagonal shape of the molded push



Speeds work in inaccessible places

button prevents rolling of the tool when it is carelessly set down.

Called Quick Wedge, the screw drivers have fluted handles, giving a good grip; for work on electric lines, the high dielectric strength of Tenite affords insulation against shock.

LUMINOUS DOTS

*Adhere to Any Surface,
Glow as Guides in Dark*

FINDING a light switch, keyhole, lamp, or alarm clock in the dark may now be simplified by a product that gives off a bright glow in the dark and never fades out. Made with "polonium," a recently discovered material, the devices, called Atomic Dots, contain no radium and can be used safely.

It is pointed out that the dots need not be exposed to frequent light as do

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RHODIUM

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RHODIUM is the rugged
new-comer. It is as surface-
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ITHACA, NEW YORK

ordinary phosphorescent and "luminous" products, yet retain their continuous glow for hundreds of hours in complete darkness. Atomic Dots are made on an adhesive base that sticks to wood, glass, metal, plastics, or any smooth, non-porous surface, they may be peeled off and placed elsewhere if desired.

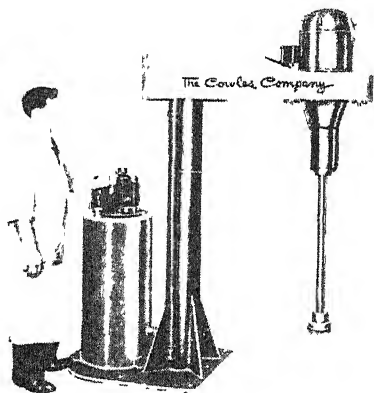
DISSOLVING MACHINE

*Handles High Viscosity
Materials at High Speed*

OPERATING on a high-speed principle that is said to introduce components of laminar flow and inter-face shear, a new dissolver is described as 2 to 20 times faster on standard dissolving and dispersing operations.

The machine exposes broad areas of contact between the solvent and solute, subjecting the particles of the material being treated to molecular tension and scrubbing action, thus increasing dissolving and dispersing speed.

High viscosities are reported to improve the shearing effect, resulting in faster dissolving or more homogeneous mixtures. Anti-friction bearings, low



Features explosion-proof design

maintenance cost, and explosion proofing are other features of the design.

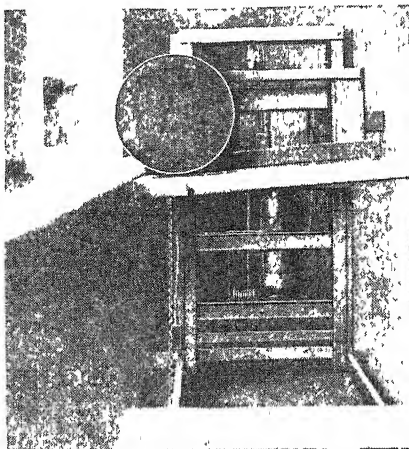
Two types are currently in production. One model has the tank permanently incorporated in the unit with capacities of 100 to 500 gallons. The second model has an elevating head, designed for use with user-furnished portable tanks.

The design of the impeller, size of motor, and tank material are specified for each job by The Cowles Company, manufacturers of the device.

BARREL LOADER

*Features Safety, Precision
Drive, Automatic Control*

A COMBINATION elevating and unloading machine for barrels is said to save considerable time and labor and to have safety features that make accidents almost impossible. A standard motor-hoist unit is used, consisting of herringbone and worm gears, motor, and magnetic brake in one sealed unit with all shafts running in oil on ball and tapered roller bearings. The outboard end of the shaft is carried on self-aligning precision ball bearings.



Barrels cannot roll off when lifted

The Revolver high-speed barrel loader is countersunk in position so that the top of the platform when lowered is flush with the floor. Barrels are rolled on to this platform by hand. The operator then throws a switch and the platform rises to the correct height for unloading where it is tilted so that barrel automatically rolls off on to the upper level. The platform then automatically returns to the lowered position for another loading.

Barrels cannot roll off the inclined platform on the way up because of a raised stop which drops down at the proper height allowing barrel to roll off. The machine can be made portable by equipping the frame with wheels if this is desired. The manufacturer, the Revolver Company, advises that the elevator design may be adapted for raising various size barrels, drums, or hogsheads to any reasonable height.

HIGH-FREQUENCY HEATER

*Interchanges Oscillators for
Induction or Dielectric Use*

A DUAL-PURPOSE single unit, suitable for both induction (metal) and dielectric (non-metal) heating operations, is designed for use in experimental laboratories, testing depots, and development research departments. Called the Ther-Monic M-285C, this combination heating generator is provided with two separate, interchangeable oscillator sections, one for induction and the other for dielectric heating. Changeover from one oscillator section to the other is said to be a simple job.

The unit is a high-frequency generator, operating on 205-245 volts, 60-cycle, single-phase power supply, and having a full-load input of 12 KVA, at 90 percent power factor. Its full-load output is 285 B.T.U. per minute or approximately five kilowatts at nominal frequencies of 375,000 cycles per second for induction heating and 20,000,000 cycles per second for dielectric heating operation. The tube complement comprises two mercury-vapor rectifiers and one water-cooled oscillator.

Developed to meet the need of laboratories for a rapid and dependable source of heat for a wide variety of heating applications, the heater is suitable, when operating as an induction heating unit, for thin case-hardening, heat

treating, through hardening for metallurgical processing, brazing, forging, melting, and soft soldering.

When operating as a dielectric-heating unit, it efficiently heats non-conducting materials. Textile processing, wood gluing and laminating, dehydration of foods, pre-heating and polymerizing of plastics, sterilization and defestation of packaged foods, rubber curing, and foundry core baking are included in the applications.

Also, petroleum laboratories will find this unit useful in removing water from oil-water emulsions without raising the temperature of the oil excessively. In chemical laboratories, dielectric heating will evaporate liquids, such as drugs, chemical solutions, and fruit juices. Rapid and uniform heat for producing desired chemical reactions can also be provided. Other applications are the treating, drying, and processing of leather, paper, tobacco, drugs, cork, ink, and ceramics.

This Induction Heating Corporation's generator weighs 1400 pounds, is 36 inches wide, 28 inches deep, and 62½ inches high.

RE-REFINING

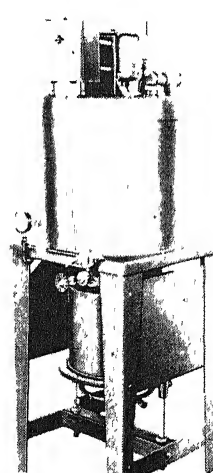
*Fits Used Lubricating
Oil for Further Use*

CAPABLE of restoring used lubricating oil to the quality of new oil, a new oil refiner especially adaptable to Diesel locomotive drainage is said to remove not only solid suspended impurities, but dissolved contaminants, acids, and fuel dilution as well. It is also claimed to impart anti-varnish and anti-ringing-sticking qualities to the oil.

According to the Youngstown Miller Company, the manufacturer, many harmful impurities, such as moisture, solvents, asphaltines, and so on do not yield to extraction by ordinary methods of reclaiming. The new unit, however, is said to accomplish this end by contact filtration—simulating the process used in the refining of crude oil.

In this process, the dirty oil is pumped to a heating chamber under automatic float control and adsorbent earth is added in suitable proportion. The two are then thoroughly mixed by means of an agitator and are heated electrically. The removal of volatiles is hastened by the evaporative effects of

Oil reclaimer removes both solid and dissolved impurities by contact filtration in a two-stage process. Controls are automatic thermostats



Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature giving further details of a more specialized nature.

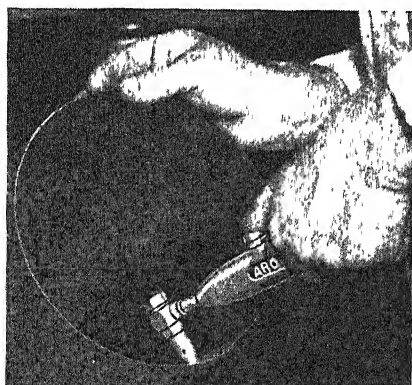
a continuous stream of fresh air which is passed across the oil surface, permitting lower operating temperatures than would otherwise be possible. Heaters are under automatic thermostatic control.

When the unit signals that the proper temperature has been reached, the oil and earth mixture is dropped to a transfer tank from which it is forced into a two-stage filter press by air pressure. Here all solids, including the adsorbent materials, are removed.

DESCALING HAMMER

Is Air-Driven, Also
Peens Metal, Sets Rivets

AIR-POWERED, a new peening and scaling hammer is described as filling a long-felt need in the industrial field for a hammer-type tool for removing



5000 blows per minute

scale and rust on welded parts. It can also be used for removing sand on small castings and peening tubular rivets and other small parts.

This Aro Equipment Corporation tool delivers 5000 blows per minute, but is said not to distort light sheet metal when removing scale. Piston and cylinder are of alloy steel, precision ground. Overall length of the hammer head is 2½ inches and the tool is 7 inches in length. Small enough to get in tight places, the tool has a connection between the hammer head and body that can be any desired length. The body of the tool is cast aluminum with an automatic throttle valve.

TRANSPARENT CONDUCTOR

Coats Glass to Carry
Electrical Current

A METHOD of eliminating aircraft windshield icing and interior fogging involves the use of a permanent transparent coating for glass that success-

fully conducts electrical current over the glass panel. Called Nesa, the coating on the glass makes it possible to heat the entire area of the panel uniformly.

Neither distortion of vision through Nesa-treated glass nor any material reduction in the intensity of light transmission through the coating is apparent, according to the Pittsburgh Plate Glass Company. In addition to the de-icing and de-fogging characteristics, another advantage of Nesa-treated glass for aircraft windshields is that it actually strengthens them against impact at low atmospheric temperatures. This is because the vinyl-plastic interlayer of laminated plate glass should range from 80 to 120 degrees, Fahrenheit, for the most efficient protection. Thus, when the Nesa-treated glass is subject to low temperatures, the electrical current passing over the glass coating will maintain the plastic interlayer within this range, thus increasing its resistance to collision with birds.

Electrical contact to the transparent coating is made by applying metallic bus bars to the edges of the glass area. The treatment can be effected on plate glass, laminated safety glass, and multiple-glazed units designed for both civilian and military aircraft.

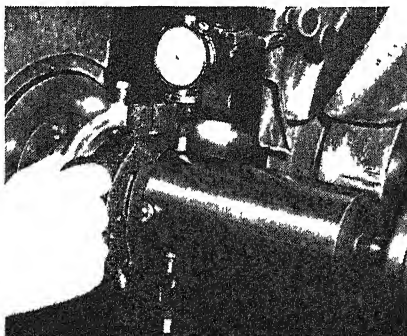
Development of Nesa-treated glass is attributed to the extensive research for a satisfactory glass for use on radar equipment and for covers for various types of electronic instruments and dials. When untreated glass was used for these purposes, static electricity would collect on the surface and cause deflection of the registering mechanisms of the instruments. Hence, a transparent conductive coating was needed to "drain off" the static.

DIAL SNAP GAGE

Adjusts Over Wide Range,
Has Carbide Contact Faces

A SINGLE pair of heads and four extension spacers of different lengths cover the unusually long range of four inches with substantial saving in cost on a new dial snap gage.

Using a popular sized indicator, these instruments show highly consistent repeatability, are free from whip and waver of the hand, and are easily set to a master. Both of the gaging pins are surfaced with cemented carbide to reduce wear. The lower, adjustable pin is flat while the upper one, which actuates the indicator, presents a spheri-



Amount of variation read from dial



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The Ancients Called It COSMIC CONSCIOUSNESS

Must man die to release his *inner consciousness*? Can we experience *momentary flights* of the soul—that is, become *one with the universe* and receive an influx of great understanding?

The shackles of the body—its earthly limitations—can be thrown off and *man's mind can be attuned* to the Infinite Wisdom for a flash of a second. During this brief interval intuitive knowledge, great inspiration, and a new vision of our life's mission are had. Some call this great experience a psychic phenomenon. But the ancients knew it and taught it as *Cosmic Consciousness*—the merging of man's mind with the Universal Intelligence.

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This is *not* a religious doctrine, but the application of *simple, natural laws*, which give man an insight into the great Cosmic plan. They make possible a source of great joy, strength, and a regeneration of man's personal powers. Write to the Rosicrucians, an age-old brotherhood of understanding, for a *free copy* of the book "The Mastery of Life." It will tell you how, in the privacy of your own home, you may indulge in these mysteries of life known to the ancients. Address: Scribe N. K. E.

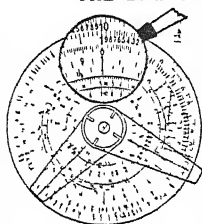
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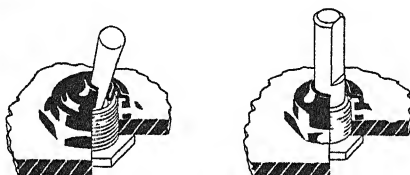
cal surface. The gage is operated by passing it over the work piece and noting the greatest deflection of the hand as the reading.

Using any extension spacer, the Decimatic Dial Snap Gage, made by Standard Gage Company, is adjustable over a range of one inch. Sets comprising a complete gage and three extra spacers are available and cover either the range of zero to four inches or four to eight inches.

SEAL NUT

Prevents Entrance of
Foreign Matter to Equipment

To PREVENT dirt, water, or gas from entering equipment panels around switch and control shafts, a new mounting and sealing nut has been developed. In use, an elastic sleeve tightly grips the protruding shaft or switch handle. The base of the nut is



Elastic sleeve grips switch handle;
rubber ring seals nut to panel face

sealed to the panel by an internal rubber ring which permits metal-to-metal contact between nut and panel to ensure solid mounting.

Applications of the Sealnut include pressurized and moisture-proof equipment, whether operating submerged, at high altitudes, or exposed to the elements. Another use, according to the makers, Radio Frequency Laboratories, is protecting equipment used in the presence of dusts and corrosive fumes. As described, the nut may be substituted for the standard mounting nut on components of equipment now in service without further alterations.

SMALL THERMOSTAT

Carries Heavy Current,
Suits Many Applications

A COMPACT thermostat for general application at 120-240 volts a.c. is only 1-9/16 inches in diameter and 1-7/32 inches in depth. The manufacturer claims that this unit, called a Type A Cam-Stat, has many features formerly found only in thermostats of larger proportions. These include a high current carrying capacity without the necessity of a condenser, differentials as low as two degrees, Fahrenheit, a selection of temperature ranges from minus 50 to 350 degrees, Fahrenheit, resistance to vibration, switching arrangements of single-pole, single-throw—break or make on temperature rise—and single-pole, double throw and independent circuit double throw.

It is pointed out that these features make the Type A Cam-Stat suited for such applications as water heaters, furnace fans, furnace limit controls, room

thermostats, or wherever the use of a general purpose thermostat is indicated. Ruggedly constructed of aluminum and plastics, it is claimed that the Cam-Stat will give long, trouble-free service.

HARD METAL ROUNDS

Come "As-Extruded" or
Centerless Ground

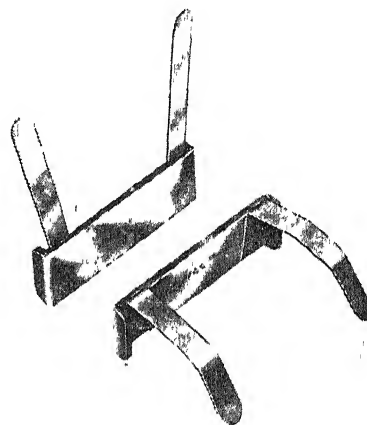
AVAILABLE in two straight tungsten carbide grades, KJ25 and KE7, with a Rockwell hardness of 89.0 and 91.0, respectively, a new line of extruded rounds has been developed primarily for use as wear-resistant elements, and are suitable for such applications as guides, feeding fingers for automatic machines, rollers, guide rails, laps, scribes, points for engraving tools, thread checking wires, and so on.

These extrusions, according to Kennametal Inc., are obtainable either rough extruded or centerless ground, in diameters ranging from 1/32 to 3/4-inch in 1/32-inch steps, and in standard lengths in even inches from 1 to 10 inches. Intermediate diameters can be furnished.

VISE CAPS

Produced in Soft
Metals and Plastics

CALLED Softfaces, and made in seven different sizes ranging from three to six inches, a new line of vise-jaw caps protect surfaces with copper, brass, or plastics. The metal caps are made from



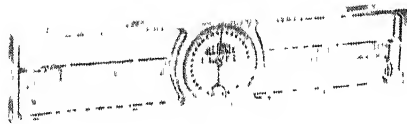
Work held without damage

mill bars which provide smooth, soft surfaces, without hard spots, to grip most classes of finely finished work. Plastics caps are suggested for finely finished, soft-metal surfaces.

DIAL INDICATOR

Provides 360-Degree
Range for Spirit Level

OF INTEREST to industries employing carpenters, shipbuilders, construction men, surveyors, inspectors, or jig makers is a new aluminum spirit level with a dial indicator in the center. Known as the All-Angle Level, the heat-treated tool weighs less than one pound, is rustproof, and may be used



Accurate within one-half degree

in any position. The dial indicator—described as accurate to within one half degree—is protected by an unbreakable-type crystal and is calibrated through a 360 degree range for accuracy.

Two air-bubble tubes, one for horizontal use and one for plumb testing, are incorporated, one on each end. A little over 14 inches long, with a width of three inches, the level is manufactured by the Brand Tool Company.

CASTING FLAWS

*Detected Before Machining
By Air-Water Testing*

POSSIBILITIES of oil or water leaks occurring in Ford cylinder blocks or heads are now said to be virtually nonexistent due to adoption of specially-designed air-test equipment. All production cylinder blocks and heads now are thoroughly air-tested, this replaces the costlier and less accurate water-test method formerly employed.

The testing machines simultaneously seal all orifices, pump 300 pounds of air pressure into the block or head, then immerse and rotate the casting slowly for several seconds in a tank of water. The slightest leak reveals a tell-tale bubble.

Rusting is averted by the addition of a rust inhibitor and it is reported that the technique virtually eliminates all defective blocks before extensive and costly machining and build-up operations are accomplished. The new machines are also faster, cycle time being 60 per hour compared with 40 for the water-test machines.

FUSE TOOL

*Pulls Safely, Checks
Circuit by Neon Light*

A TRANSPARENT plastics housing on an electrical tool—a fuse puller at one end



Used safely without protective gloves

and fuse tester at the other—affords insulation against shock and permits handling without the use of bulky gloves. In addition, since the Tenite plastics is low in heat conductivity, the housing remains comfortable to bare hands in heat or cold.

Inside one of the handles of this tool is a small neon light, the glow of which is visible through the plastics when a proper connection is tested.

MAGNIFYING LOUPE

*Fits Over Head, Adjusts
to Convenient Positions*

SUPPLIED with a lens system in either of two powers, a new head loupe supplements portable and stand models of Super Sight loupes. Worn with or without glasses, it is supplied with a bracket permitting the lens system to be set in any position.

The flexibility of the mounting allows the lens holder to be moved in or out, up or down, as an aid in projecting an object in the inspection



Aids both depth perception and vision

position. Also, it may be pushed up out of vision when not needed.

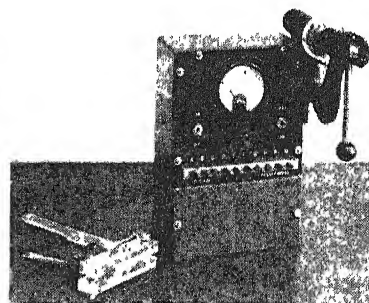
It is explained that this feature of a completely adjustable bracket is important to those having occasion to use this type of equipment in industries where depth perception together with good magnification are vital. Both hands are free for work.

The back headband, of fiber formed to fit the lower head, is adjusted by a knurled nut with a right and left-hand thread to provide a floating suspension that can be worn over long periods of time without fatigue. The lens holder also acts as an eye shade. Loupes are available, according to The Boyer Campbell Company, in 1¾ diopters, 13 inch focal length; and 2½ diopters, 9 inch focal length.

SUDSLESS SOAP

*Does Not Form Curd,
Industrial Uses Seen*

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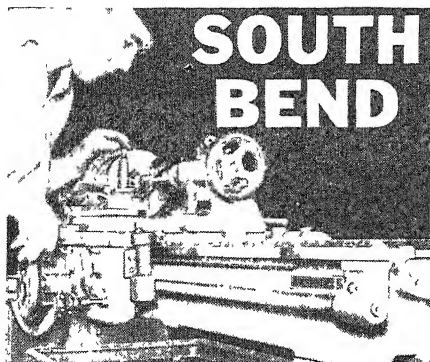
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available under the name Sterox. Overflows resulting from foaming of conventional laundry soaps and powders when excessive amounts were used are said to be eliminated by the sudsless synthetic soap.

Sterox, now being made by Monsanto Chemical Company's Phosphate Division, is termed a non-ionic, or non-curd forming, detergent. Hence, it will not combine with metallic substances found in tapwater to form insoluble curds which normally cause the familiar greasy washtub ring, leave grayish deposits on rinsed clothes, and frequently lead to clogged drains.

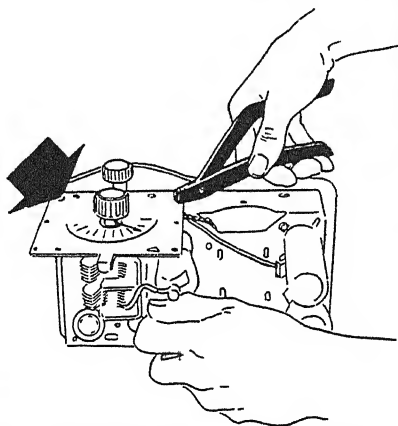
The developers also forecast industrial uses of Sterox in textile, metal cleaning, commercial laundry, and other industries in which quick, thorough, non-injurious cleansing operations are important to production.

HOLLOW RIVETS

*For Small Jobs, Set
With One-Hand Tool*

AN INEXPENSIVE, light-duty, blind rivet "gun" has been added to the Cherry line of blind-riveting tools.

The Junior Riveter, a one-handed, plier-like tool that installs the rivet



Installs hollow "pull-through" rivets

with a simple "pull," is made especially for the many small fastening jobs common to any shop. It installs a new 3/32 inch-diameter blind rivet, provided in three grip lengths. The rivet is the pull-through, hollow type.

CASE MARKER

*Fits Roller Conveyor,
Inks Type Automatically*

A MARKING attachment for placing a continuous impression on the bottom of a case or crate as it travels along on a roller conveyor is now offered as an automatic self-inking assembly. This assembly, known as Rolacoder 50, is installed in a roller conveyor in place of one of the standard rollers. The type cylinder carries a channel or slot into which the interchangeable rubber type is inserted. Inking is by two felt ink rollers in contact with the type.

The device will imprint a code or mark repeating approximately every six inches. Thus, one full imprint, at least, appears on cases as short as six



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DIAMOND TOOLS By Paul Grodzinski

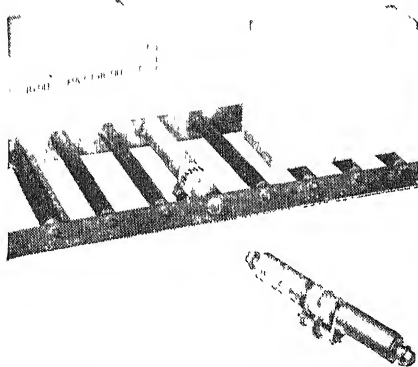
Technical consultant, Industrial Diamond Review, London

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Uses so far developed include slip-covers, gloves, sweaters, and surgical bandages, but it is not intended for use in girdles, corsets, and other foundation garments. It has a lower degree of tension than materials deriving their elasticity from rubber.

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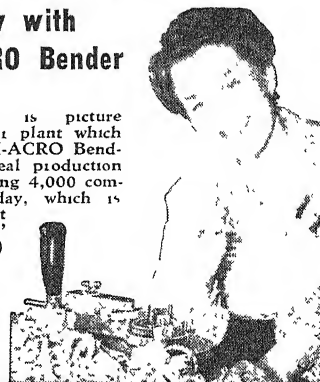


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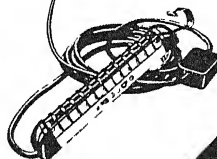
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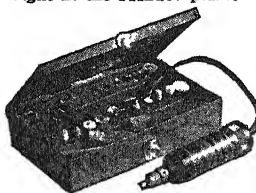
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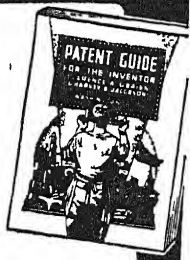
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**CURRENT BULLETIN
BRIEFS**

Conducted by K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below)

METALLIC SOAPS This 25-page booklet describes a number of individual soaps having industrial importance, and notes their physical and chemical characteristics. It also reviews some of their outstanding uses and gives hints and suggestions as to further applications. *Mallinckrodt Chemical Works, 72 Gold Street, New York 8, New York.—Gratis*

DESIGN FOR ARC WELDED STRUCTURES Produced by the colored cartoon technique, this 15 minute motion picture reviews the development of methods of fastening—from wooden pegs through nails, bolts, and rivets to modern arc welding. It then details, in simplified form, the advantages and possibilities of arc welding. *The Lincoln Electric Company, 12818 Coit Road, Cleveland 1, Ohio.—Available at no charge except for transportation.*

THE PROCEEDINGS OF THE MEXICAN-AMERICAN CONFERENCE ON INDUSTRIAL RESEARCH is a 176-page report that should prove of particular interest and service to research directors, consulting engineers, technical directors, and businessmen and manufacturers whose planning committees are considering means of intensified activity with all of our neighbors south of the border. *Mr. S. Charles Pappageorge, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois—\$2.50.*

THE OBSERVER'S HANDBOOK FOR 1947 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

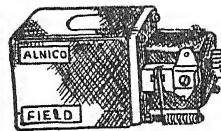
INDUSTRIAL SAFETY BRAKES. Described in this four-page bulletin are brakes that are said to have as much braking capacity as conventional brakes with but one tenth the operating pressure—thus eliminating the need for self-energizing action. These brakes range from 12 to 20 inches in diameter and are available in either self-contained or built-in types. Request Bulletin Number 460. *Linderman Devices Inc., Newburgh, New York.—Gratis.*

AIR TRANSPORTATION, by Helen R. Blank, is a six-page leaflet which evaluates air transportation as a career; discusses the nature of the work, qualifications, unions, preparation, entrance, advancement, earnings, and number and distribution of workers; and outlines its post-war prospects. With references for

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The Editor

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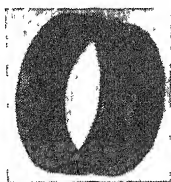
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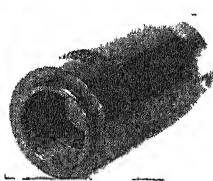
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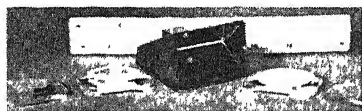
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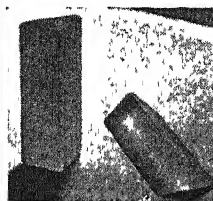


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Telescopes

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ZEISS telescopes, large ones, made pre-war, are, or were, to be found in many observatories, not alone in the lands of the late German-Italian-Japanese Axis (now the declination axis) but in many others. None are known to exist in the United States. They have a distinctive appearance shown even in the smaller, tripod size not unknown in this country—white, clean enamel, neat finish, sound mechanics, and in the large instruments a complex mechanism (Figure 1, the 49" Neubabelsberg, reflector near Berlin).

For this complex appearance a peculiar Zeiss design principle is largely responsible, the unique stress-relieving system. Probably few in this country have had opportunity to see a mounting embodying this system and, now that an amateur has built one (Figure 2), it may be time to add the type to our TN repertoire—it is not patented. An attempt to explain this Zeiss principle will follow the description of the telescope shown.

Dr. K. Hermann-Otavský, 335 Dolní Mokropsy, Praha, Czechoslovakia, writes, "I long ago read 'A.T.M.' and 'A.T.M.A.' with great interest and since the reopening of the national borders I am again following your column in Scientific American. I consider 'A.T.M.' and 'A.T.M.A.' best of all of their kind, especially as friends of astronomy from beginners to first-class experts tell in it their experiences gained by their own work and not merely from literature."

Dr. Hermann-Otavský's telescope is a neat 400-pound semi-portable type mounted on three little roller trucks so that it may be taken indoors. It is towed out by means of a folding stub tongue which steers the front truck, is spotted over hollows in three plates fixed permanently in the roof deck, and three vertical screws in the base are run rapidly down to their adjusted stopnuts with a detachable crank like a carpenter's brace. Two to four minutes suffice to complete these preparations.

The knee-shaped trunk of the mounting is a tube of sheet iron with 1.3 mm walls, reinforced inside at the knee with a welded-in plate. The knob—motor car gear lever—at this point is simply a handle for pushing the telescope. The base and diagonal brace are also of welded iron tubing. Rigidity, high. The mounting was built in a repair garage and at home, partly by the owner.

The 2" polar axis turns in Timken conical bearings and carries an hour circle of the slip-ring type. The R.A. driving worm is of tool steel and runs in oil on ball bearings and is pressed against the 9" soft iron driving wheel by a strong spring, eliminating play

The two were ground in with emery paste and they run smoothly. The slow motion controls at the eyepiece end work on a push-pull principle, eliminating play here also. In addition to the slow motions in R.A. and Decl the transmission shaft of the hour circle has a reversing differential gearing, by means of which it is possible to make infinitesimal corrections with a flexible cable. This has proved simple and convenient, and long-exposure photographs have been successfully taken at the focus of the main tube, using a marginal guide star, although the errors

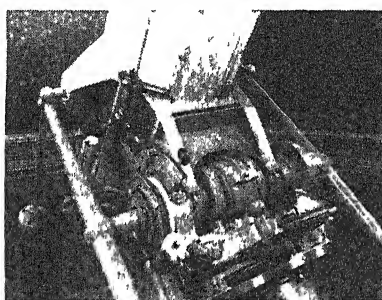


Figure 1: Typical Zeiss mounting

of guiding must not here exceed four seconds of arc.

By means of A.C. transformed to 6 volts all lenses may be mildly warmed. The same voltage lights the circles and so on. The drive is a gramophone electromotor combined with a hand-wound spring motor.

To the main tube two heavy plates are attached, with numerous holes permitting attachment of various instruments, since the mounting permits considerable overloading. When the photograph (Figure 2) was taken the mounting carried (left to right) a Zeiss C refractor $3\frac{1}{8}$ " which rates as an RFT; a Zeiss $5\frac{1}{8}$ " E refractor ($f/15$) and 2" finder (hidden); a camera with 3" Petzval lens, a monocular field glass (hidden). The optics were obtained from Zeiss and from Srb and Stys, Praha.

The main refractor has a Zeiss binocular eyepiece. Two removable achromatic Shapley lenses, the opposite of the Barlow lens, may be used for shortening the main tube focus.

Other auxiliaries include micrometers, a magnification meter, a planetary prism reflex camera with controlling ocular made by the owner, a focal camera with a side-aiming ocular, an accommodation for narrow-film cinematographic camera with mirror reflex control, and a focus-control microscope.

"Literally," Hermann-Otavský says, "there is no declination axis in the usual sense," and then mentions the standard Zeiss mountings described by

Chief Engineer Franz Meyer of Carl Zeiss, in "Zeitschrift für Instrumentenkunde," Vol 50 (1930). With the help of this and an article in "Product Engineering," New York, 1931, July, pages 290-94, and the pre-war Zeiss catalog of astronomical instruments, your scribe has tried to study out the principle of the mysterious Zeiss stress-relieving system.

In conventional mountings, precision—that is, freedom from flexure in all positions—is sought by making the axes stiff. This makes them heavy. This, in turn, increases friction in the drive. So Zeiss claims. More than 40 years ago Engineer Meyer therefore swung to almost the opposite extreme. If you can't entirely eliminate bending—and theoretically you can't—then "let 'er bend" and then neutralize it. This you can do entirely. It calls for some added mechanism.

Figures 3 and 4, from the "Product Engineering" article, exhibit the principle. Each of the two axes consists of an inner part which carries the weight—all of it—and around it *but nowhere touching it* an outer part which maintains the alignment and moves the telescope.

The inner, weight-bearing parts, shown only by theoretical lines in Figure 3, are sizable shafts, not by any means flimsy but not designed to prevent all bending.

The entire weight of the tube, its two pairs of spherical counterweights H, H , declination axis shaft D , and polar axis shaft itself including big weight K (below floor level on large telescopes), is delicately balanced on a single ball bearing pivoted horizontally on rockers on ledges in the pedestal (A , Figure 4).

Rotating with this weight-carrying polar axis shaft is the assembly consisting of the forked yoke (F , Figure 3); its lower straight extension (but not the surrounding casting that clasps the pedestal head) with R.A. worm; also tubular part Do (concentric with declination axis shaft); and bridge S connecting with and moving the main tube. These parts move as a unit in R.A.

Now, you inquire, you have given us two systems—somewhere they must connect. Yes and no. A light contact—just a kiss—occurs at O in Figure 3.

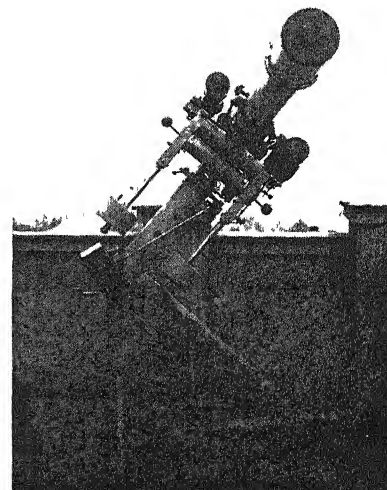


Figure 2: Hermann-Otavsky telescope

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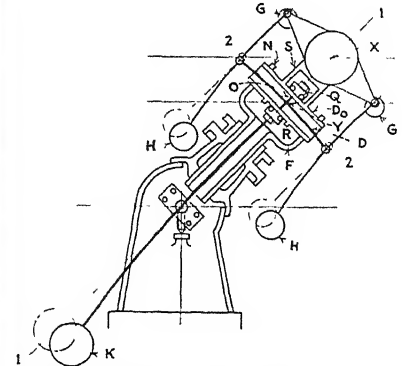
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where a cross disk is diagrammatically indicated at the middle of the declination axis (is in line with the top of the polar axis). Actually, Figure 5 is that disk and there you see how it works. Bulge O on declination axis shaft D₁, ball bearing Q, spherical surface in spherical seat (not lettered), and enough looseness at R to prevent cramping when the polar axis shaft bends. Because this ball bearing keeps



Courtesy "Product Engineering"
Figure 3 Weight-carrying system

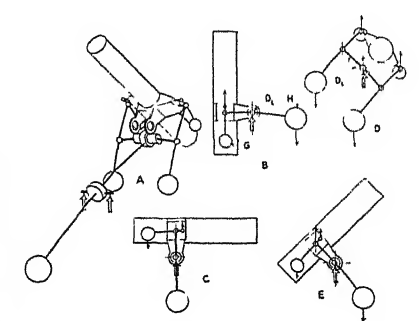
the two systems apart, yet transmits the desired drive, the claim can truthfully be made that the two systems do not touch each other at any point. Let's not quibble over this since, while the actual parts do touch through an intermediary, the stresses, which are what matter, don't.

Figure 1 shows an annular space between the hollow tubular element and the weight-bearing declination axis. The same space similarly exists in Figure 2 but does not there show.

Figure 4, A, was drawn to show that if the bridge part between the tubular element and telescope tube were purposely to be disengaged, as a demonstration stunt, it and the tube still would stay put wherever put; which shows that this assembly puts no stress on the driving element.

In the same figure, sketches B, C, D, E show how the counterweight arms isolate the stresses; there is no hidden composition of forces. It is claimed that freedom from cramping and increased precision are thus obtained.

This, then, is a scientific design. Just why it never made headway in this country your scribe knows not. Perhaps some reader does. Yet the fact that, over several pre-war decades, Zeiss made and sold many like it to large observatories seems to say that it



Courtesy "Product Engineering"
Figure 4: Balancing the weights

must have points. Amateurs desiring to experiment with it may borrow photographs of the Hermann-Otavský telescope, and of other Zeiss telescopes, not here reproduced. They should also study the two elevations in the German article cited above, these being on "Tafel 3" near page 74 (in case a photostat is sought from some library).

In the pre-war Zeiss catalog, today scarce if not rare, is the following summary of the Zeiss stress-relieving system and telescopes.

"The movable parts of the equatorial mounting are divided up into two distinct equatorial components, viz —

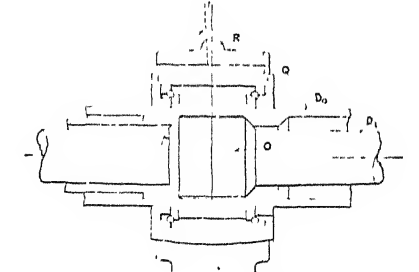
1) an equatorial directing system comprising the optical parts and enabling the telescope to be directed upon astronomical objects in terms of the coordinates (hour angle and declination),

2) an equatorial system of carriers for taking up any stresses in the directing system.

The catalog continues. "The equatorial telescope mountings with stress-relieving system fulfill the following requirements

1) They obviate flexure in the telescope and in the polar and declination axes, and ensure easy movement of the axes by reason of all stresses being completely relieved in the carrying system.

2) Several telescopes may be assembled side by side on one mounting and any mutual tendency to deformation compensated by the stress relieving system.



Courtesy "Product Engineering"
Figure 5 The stealthy go-between

3) The tubes are freely movable through all ranges of the hour and declination angles without encountering obstruction by any part of the mounting or stand.

4) The tubes are so mounted as to continue the movements of the eye within a very small range, the eye being applied at a point near the intersection of the polar and declination axis.

5) The design affords easy access from the observer's position at the eye end to all attachments."

Close study of Figure 2 reveals that the telescope described does not embody all the standard details of the Zeiss mounting. For example, the counterweight K of Figure 3 is absent. This telescope was too small to justify a Chinese copy of the original. But the main feature is embodied; note the two knobs in Figure 2. These correspond to 2,2 of Figure 3 and emerge like wrists through loose cuffs which do not touch them, just as in Figure 1.

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— X —

X-RAY photometer	
2,000,000-volt	

